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The Motor Fuel Consumption Model

Eleventh Periodical Report

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1. INTRODUCTION

This document is the eleventh of a series of periodic reports on the Motor Fuel Consumption (MFC) model developed for the Department of Energy (DOE), Office of Policy Integration, Office of Policy, Planning and Analysis (1-12).* The current report has been prepared for the U.S. Environmental Protection Agency, Office of Mobile Source Air Pollution Control, Emission Control Technology Division with funds provided by the U.S Department of Energy under an Inter-Agency Agreement.** The MFC model is used by DOE to evaluate the impact of conservation policies on fuel consumption and on the disaggregate components of fuel demand. These components include passenger cars, light-duty trucks, and heavy-duty vehicles. The model is not a forecasting tool in that it does not provide detailed econometrically-based projections of fuel demand. The model is, however, calibrated to current statistics on fuel consumption, fleet size, and travel growth, and to econometric forecasts of new vehicle sales provided by DOE.

During the past year (September 1983 - October 1984), the MFC model has been used to evaluate: 1) the effects of revised estimates of misfueling and discretionary switching on leaded gasoline, and 2) changes in Corporate Average Fuel Economy (CAFE) levels. The model also has been used to support DOE analyses of historical trends in fuel use and

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*In previous reports, the model has been called the "Highway Fuel Consumption Model." Due to the addition of an off-highway gasoline component, the model has been renamed as the "Motor Fuel Consumption" model.

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efficiency in the passenger car, light truck, and commercial trucking modes of transportation. To facilitate an analysis of the total leaded gasoline market, the model has been expanded to include off-highway gasoline consumption. In addition, the truck classification scheme employed by the model has been revised to develop fuel consumption estimates for vehicle classes which are more homogeneous in terms of fuel economy, technology penetration and usage characteristics.

The purpose of this report is to acquaint the reader with the most current output of the Motor Fuel Consumption model and to discuss revisions in the model structure, input data and assumptions which have occurred in the past year. The report is briefly summarized in Section 2. Section 3 presents the current projection of motor fuel consumption and compares it to the one used in the preceding report of this series. Section 4 describes recent activities involving the use of the model. A description of the basic model structure and methodology is presented in Appendix A. Copies of the October 1984 output of the model are attached in Appendix B and Appendix C.

2. SUMMARY

The year 1984 has witnessed the continuation of a dramatic turnaround in automobile sales since 1982 for the U.S. motor vehicle industry. Total model year (MY) 1984 car sales soared well above the 10 million mark and are more than 18 percent over the MY 1983 total. The domestic automobile makers also have recaptured market share from the imports. Between 1983 and 1984, import car penetration fell by 2.5 percentage points from 26.5 percent to 24.0 percent.

While these gains have fueled a return to profitability for the U.S. automobile industry, they also have brought other changes. Diesel sales in the first half of 1984 tumbled 29 percent below the comparable period for 1983 and it is not likely that this decline will be reversed in the foreseeable future. Two of the major U.S. domestic automobile manufacturers had average mpg values below the level of the Corporate Average Fuel Economy (CAFE) standards for MY 1984 cars and are projected to be below the standard again in MY 1985.

The petroleum industry continues to experience turbulence in the market for motor gasoline. Total motor gasoline consumption (in million barrels/day) for the period January-August 1984 averaged 1.6 percent higher than the level for the same period in 1983 (34). Despite this growth in motor gasoline consumption, the current period of relatively stable fuel prices and abundant supplies of crude oil continues to intensify competition in the downstream oil products market. As a reflection of this trend, the number of gasoline service stations in operation shrunk by 10.4 percent between 1982 and 1984.

The current upward swing in total gasoline usage will be temporary. Gasoline demand will turn downwards in the balance of the 1980's and remain flat in the early 1990's (see Figure 2-1). By 1995, total gasoline consumption will be 5.9 MMB/D (9.6 percent below 1982 levels).* The bulk of this decline can be attributed to the ongoing introduction and expanded use of cost-effective fuel efficient technologies in new cars and light trucks. As a result, new domestic car EPA fuel economy will reach 32.0 mpg by 1990 and 35.8 mpg by 1995 -- a 51 percent and 69 percent increase, respectively, over the 1980 levels (see Table 2-1). Within the total gasoline component, the volume of unleaded fuel will continue to expand as a result of the growth of catalyst-equipped vehicles in the fleet. By 1995, unleaded gasoline will reach 4.9 MMB/D or 82.9 percent of total gasoline consumption.

Total diesel highway fuel demand will continue to grow over the next two decades primarily under the impetus of diesel penetration of the heavy-duty vehicle segment of the fleet. Total highway diesel fuel use will increase 46 percent from 0.96 MMB/D in 1982 to 1.4 MMB/D by 1995.

Much of the drop in total motor fuel consumption can be attributed to the improvements in passenger car fuel efficiency noted above which are expected to continue into the future. As illustrated in Figure 2-2, passenger car fuel consumption will drop from 4.5 MMB/D (or 60.3 percent of total motor fuel demand) in 1982 to 3.8 MMB/D (or 51.6 percent of total motor fuel demand) in 1995.

The fuel demand projections shown in Figures 2-1 and 2-2 are derived using the Motor Fuel Consumption (MFC) model originally developed for the U.S. Department of Energy (DOE) and recently modified for the U.S.

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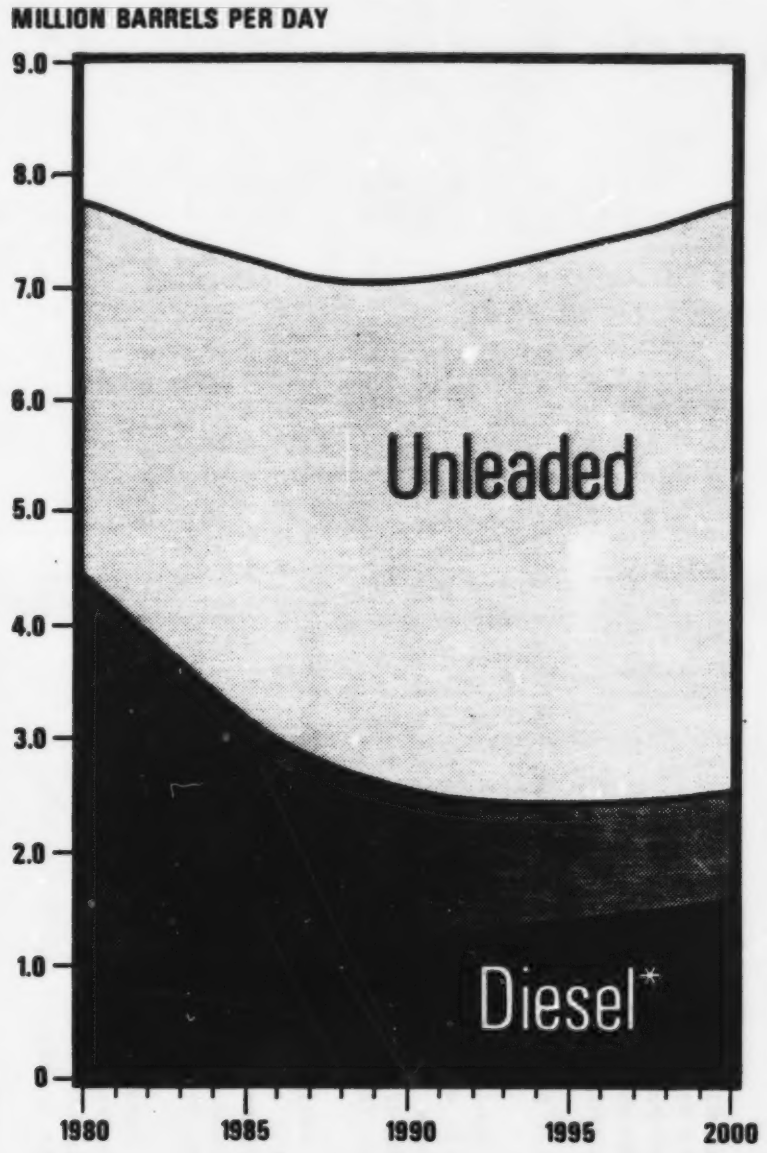
*MMB/D: millions of barrels per day.

FIGURE 2–1

Motor Fuel Consumption By Fuel Type



* Off-highway diesel not included

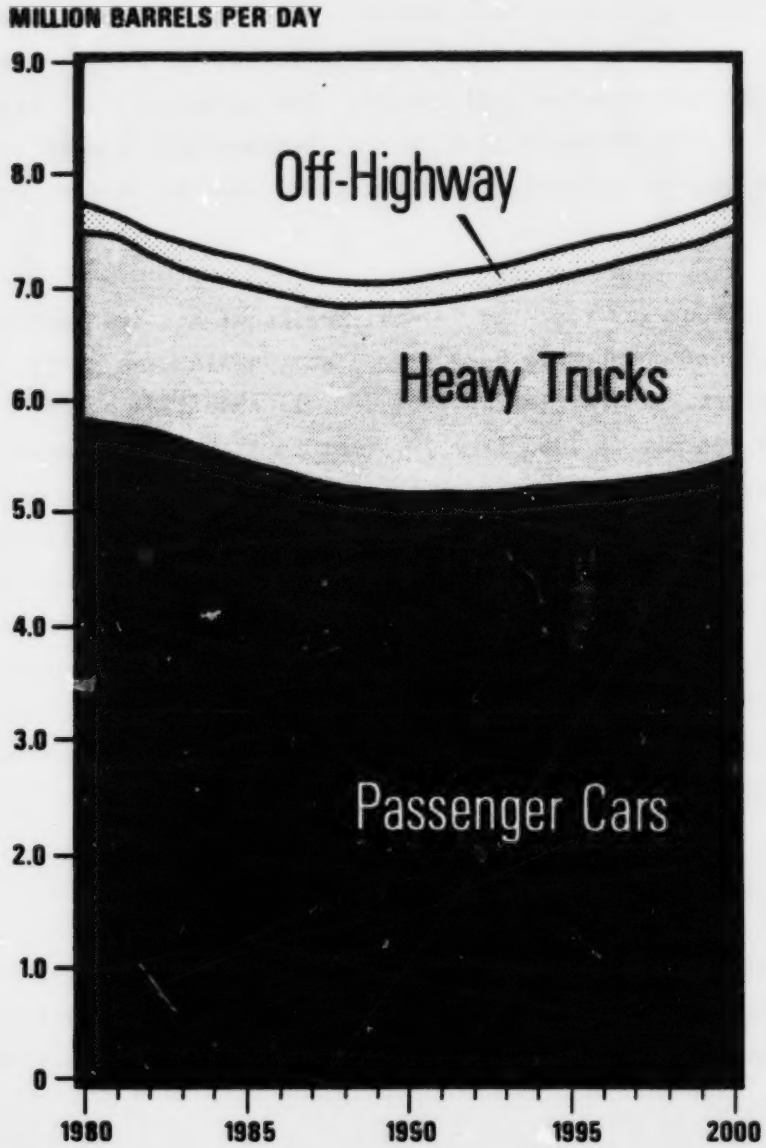
TABLE 2-1

MFC MODEL SUMMARY DATA FOR HIGHWAY VEHICLES
OCTOBER 1984 OUTPUT

	1980	1985	1990	1995	2000
Total Highway Fuel ($x10^9$ gal)	115	108	105	109	115
Heavy-Duty Vehicles	26	24	26	29	32
Light-Duty Vehicles	89	84	79	80	83
Automobiles	73	65	59	58	59
Light trucks	16	19	20	22	24
Diesel Percent of Total Highway Fuel	12.7	14.6	17.6	19.8	21.1
New Vehicle EPA MPG					
All automobiles	23.4	27.2	33.0	36.6	36.6
Domestic	22.0	25.9	32.0	35.8	35.8
Imported	28.7	32.4	36.3	39.1	39.1
Light Trucks (0-8,500 lbs GVW)	18.4	21.2	24.4	27.1	27.1
New Vehicle Diesel Penetration (Percent)					
All automobiles	4.2	1.2	1.8	2.2	2.2
Domestic	4.6	0.8	1.3	1.5	1.5
Imported	3.5	2.6	3.0	4.0	4.0
Light Trucks (0-8,500 lbs GVW)	2.4	2.9	3.4	4.7	4.7
EPA Versus On-Road MPG Shortfall (Percent)					
Domestic cars	13.7	13.2	15.8	17.4	17.4
Import cars	16.7	15.9	17.5	18.5	18.5
Light Trucks (0-8,500 lbs GVW)	15.9	14.7	16.1	17.1	17.1
Import Share of New Car Sales (Percent)	26.2	24.2	26.6	27.0	27.0
Price of Gasoline (1980 ¢/gal)	122	101	107	113	119

FIGURE 2–2

Motor Fuel Consumption By Vehicle Type



Environmental Protection Agency (EPA) and DOE. The input data for the MFC model are revised periodically to incorporate: 1) the most current historical statistics available, and 2) updated projections of the factors influencing highway fuel demand. As shown in Table 2-2, changes in these factors can have a significant influence on the level and composition of future motor fuel demand. For example, total highway fuel demand in 1990 increased 9.8 percent between the date of issuance of the Tenth Quarterly Report (November 1983) and the current output of the model.

The current output incorporates several modifications to the input data for the MFC model which have been made since publication of the Tenth Quarterly Report. Major changes include: 1) reduction of new domestic car EPA fuel economy in 1985 from 27.1 mpg to 25.9 mpg to account for delays in new model introductions, revised estimates of fuel economy technology benefits, and shifts in vehicle size class mix; 2) restructuring of the light-duty truck and heavy-duty vehicle classification by gross vehicle weight based on recent analysis of technology and vehicle use trends in these sectors; 3) revised estimates of diesel penetration; 4) modifications in EPA to on-road fuel economy shortfall relations; and 5) calibration of the model to 1982 statistics on cars and trucks in operation and fuel demand.

The changes discussed above (and others) are outlined at length in Sections 2.2, 2.3, and 3 of this report. In addition, Appendix B presents detailed data on the annual fuel consumption of: 1) highway leaded and unleaded gasoline and diesel fuel by seven categories of motor vehicles, and 2) leaded and unleaded gasoline used in off-highway applications.

TABLE 2-2

SUMMARY COMPARISON OF THE CURRENT MFC MODEL OUTPUT
VERSUS THE TENTH QUARTERLY REPORT

	October 1984 Output #1		Tenth Quarterly Report #2		Percent Change (#1-#2)/#1 percent	
	1990	2000	1990	2000	1990	2000
Total Highway Fuel ($x10^9$ gal)	105	115	96	97	+ 9.4	+18.6
Heavy-Duty Vehicles	26	32	20	22	+30.0	+45.5
Light-Duty Vehicles	79	83	76	75	+ 3.9	+13.3
Automobiles	59	59	56	59	+ 5.4	+11.1
Light trucks	20	24	20	21	0.0	+14.3
Diesel Percent of Total Highway Fuel	17.6	21.1	19.0	24.8	- 7.4	-14.4
New Vehicle EPA MPG						
All automobiles	33.0	36.6	35.8	40.2	- 7.8	- 9.0
Domestic	32.0	35.8	33.9	38.2	- 5.6	- 6.3
Imported	36.3	39.1	42.7	46.8	-15.0	-16.5
Light Trucks (0-8,500 lbs GVW)	24.4	27.1	26.9	29.2	- 9.3	- 7.2
New Vehicle Diesel Penetration (Percent)						
All automobiles	1.8	2.2	10.0	10.0	-82.0	-78.0
Domestic	1.3	1.5	10.0	10.0	-87.0	-85.0
Imported	3.0	4.0	10.0	10.0	-70.0	-60.0
Light Trucks (0-8,500 lbs GVW)	3.4	4.7	18.8	20.6	-82.0	-77.2
EPA Versus On-Road MPG Shortfall (Percent)						
Domestic cars	15.8	17.4	12.7	14.1	+24.4	+23.4
Import cars	17.5	18.5	18.3	19.9	- 4.4	- 7.0
Light trucks (0-8,500 lbs GVW)	16.1	17.1	15.2	14.6	+ 5.9	+17.1
Import Share of New Car Sales (Percent)	26.6	27.0	25.2	26.8	- 5.3	- 0.7
Price of Gasoline (1980 ¢/gal)	107	119	115	127	- 7.0	- 6.3

3. MOTOR FUEL DEMAND

This section briefly summarizes the current output of the Motor Fuel Consumption model. Subsection 3.1 outlines the trends in motor fuel demand by fuel type. The changes in the current output vis-a-vis the Tenth Quarterly Report* are highlighted in subsection 3.2. Subsection 3.3 provides specific detail on the input data and assumptions used to generate the MFC model output.

3.1 TRENDS IN MOTOR FUEL DEMAND

Table 3-1 presents motor fuel demand by fuel type for highway and off-highway applications.** Total gasoline demand drops from 100.5 billion gallons (6.6 MMB/D) in 1982 to 90 billion gallons (5.9 MMB/D) in 1990 at an effective annual rate of 1.4 percent per annum, and then rises to 94.5 billion gallons (6.2 MMB/D) by the turn of the century. This trend is largely attributable to changes in the relative rates of growth in the average on-road fuel economy versus travel of highway vehicles. Fleet average on-road fuel economy increases at 3.9 percent per year through 1990 and then drops to 2.0 percent through the year 2000. Total travel, on the other hand, rises at 2.4 percent annually through 1990 and then increases slightly to 2.5 percent per year through the turn of the century.

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*All references to the Tenth Quarterly Report refer to Reference 12.

**This does not include off-highway diesel fuel used in railroad, marine, agriculture, construction, etc. applications.

TABLE 3-1

TOTAL MOTOR FUEL CONSUMPTION
(billions of gallons)

	Highway Gasoline				Off-Highway Gasoline				Total Gasoline				Total Diesel			Total Motor Fuel		
Year	Leaded	Un-leaded	Total	Percent Unleaded	Leaded	Un-leaded	Total	Percent Unleaded	Leaded	Un-leaded	Total	Percent Unleaded	Highway	Off-Highway	Total	Highway	Off-Highway	Total
1980	49.46	50.61	100.07	50.6	3.12	0.57	3.69	15.4	52.58	51.18	103.76	49.4	14.53	*	**	114.60	**	**
1981	46.35	52.88	99.23	53.3	2.71	0.57	3.27	17.4	49.06	53.45	102.51	52.2	14.86	*	**	114.09	**	**
1982	42.68	54.58	97.26	56.1	2.58	0.68	3.26	20.9	45.26	55.26	100.52	55.0	14.70	*	**	111.97	**	**
1983	38.29	56.69	94.98	59.7	2.51	0.74	3.25	22.8	40.80	57.43	98.23	58.5	14.94	*	**	109.92	**	**
1984	34.01	59.50	93.51	63.6	2.44	0.80	3.25	24.6	36.46	60.30	96.76	62.3	15.33	*	**	108.84	**	**
1985	30.31	61.74	92.05	67.1	2.40	0.85	3.25	26.2	32.71	62.59	95.30	65.7	15.77	*	**	107.82	**	**
1988	21.95	65.80	87.75	75.0	2.24	1.03	3.28	31.4	24.20	66.84	91.04	73.4	17.24	*	**	105.00	**	**
1990	18.25	68.49	86.74	79.0	2.18	1.14	3.31	34.4	20.43	69.62	90.05	77.3	18.48	*	**	105.22	**	**
1995	13.34	74.16	87.50	84.8	2.18	1.28	3.47	36.9	15.52	75.45	90.97	82.9	21.56	*	**	109.06	**	**
2000	12.25	78.51	90.76	86.5	2.25	1.45	3.70	39.2	14.50	79.96	94.46	84.6	24.22	*	**	114.98	**	**

*Off-highway diesel fuel consumption (i.e., fuel used in marine, railroad, agricultural, construction, and stationary engine applications) was not included in the framework of the model.

**Not calculated since off-highway diesel has not been explicitly included in the model.

Total off-highway gasoline use rises slowly from 3.3 billion gallons in 1982 to 3.7 billion gallons in the year 2000. Reflecting a continuation of historical trends, off-highway gasoline use will remain a small 3-4 percentage of total gasoline demand.

As the percentage of highway vehicles requiring unleaded gasoline continues to rise, the total demand for unleaded will grow to 66.8 billion gallons (73.4 percent of total gasoline demand) by 1988. In the post-1988 time period, the growth in unleaded gasoline use will slow as the fleet of catalyst-equipped vehicles stabilizes. Leaded gasoline demand will drop from 24.2 billion gallons (26.6 percent of total gasoline) in 1988 to 15.5 billion gallons (17.1 percent of total gasoline) by 1995.* At this point (1995), 49.1 percent of total leaded gasoline consumption will be attributable to misfueling by owners of catalyst-equipped vehicles, 36.8 percent will be accounted for by non-catalyst vehicles designed for leaded, and the remainder (14.1 percent) will be consumed in off-highway applications.

The diesel share of total vehicles in operation rose from 2.2 percent in 1981 to 2.6 percent in 1982. Despite the slump in sales of new passenger cars and light trucks in 1983 and 1984, diesels will rise slowly to about 4.7 percent of the total fleet by 1995 as the engines become a more widely available option in automobile and light truck model lines and increase the penetration of the heavy truck market. As a result, diesel fuel demand will increase from 14.7 billion gallons (0.96 MMB/D) in 1982 to 21.6 billion gallons (1.4 MMB/d) by 1995.

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*This assumes continued availability of leaded gasoline and continued misfueling by owners of catalyst-equipped vehicles.

As shown in Tables 3-2, 3-3, and 3-4, continued improvements in new vehicle fuel economy through the 1980's will cause the passenger car and light-duty truck* share of total highway fuel demand to drop from 78.4 percent (87.8 billion gallons) in 1982 to 73.5 percent (80.2 billion gallons) by 1995. Despite the growth in fuel economy of heavy-duty vehicles in the 1980's, their share of total highway fuel consumption will grow from 21.6 percent to 26.5 percent (28.9 billion gallons) by 1995. This arises from differences in the relative trends in average fuel economy and VMT. Between 1982 and 1995 passenger car and light-duty truck average on-road fleet mpg will grow at an annual rate of 3.4 percent in comparison with 2.9 percent for heavy-duty trucks. Moreover, passenger car and light-duty truck total annual miles will rise at only 2.7 percent per year through 1995, while heavy-duty vehicle VMT will grow at 4.3 percent per annum over the same time period.

3.2 COMPARISON WITH THE TENTH QUARTERLY REPORT

Tables 3-2 through 3-4 also compare the current output of the model with the one drawn from the Tenth Quarterly Report. A number of modifications have been made. These changes are presented in summary form in this subsection and are more fully detailed in subsection 3.3. We have:

- Reconfigured the light-duty truck and medium- and heavy-duty vehicle categories as follows:

Tenth Quarterly Report	Current Output
0-6,000 lbs GVW Domestic LDT	0-8,500 lbs GVW Domestic LDT
0-6,000 lbs GVW Import LDT	0-8,500 lbs GVW Import LDT
6,001-8,500 lbs GVW All LDT	8,501-14,000 lbs GVW Light Hvy
8,501-10,000 lbs GVW All LDT	14,001-50,000 lbs GVW Med Hvy
10,001-19,500 lbs GVW Medium Hvy	50,000+ lbs GVW Hvy Hvy
19,501-26,000 lbs GVW Light Hvy	
26,001+ lbs GVW Heavy Hvy	

*Cars and light trucks under 8,500 lbs GVW.

TABLE 3-2

FUEL CONSUMPTION BY VEHICLE TYPE
(billion gallons)

	October 1984 Output					Tenth Quarterly Report				
Year	Passenger Cars	Light Trucks 0-8,500 lbs GVW	Heavy-Duty Vehicles	Total Trucks	Total	Passenger Cars	Light Trucks 0--8,500 lbs GVW	Heavy-Duty Vehicles	Total Trucks	Total
1980	73.37	15.71	25.52	41.23	114.60	73.37	21.12	20.11	41.23	114.60
1981	71.72	16.80	25.58	42.38	114.09	71.72	22.28	20.10	42.38	114.09
1982	69.43	18.38	24.21	42.54	111.97	68.53	21.56	19.82	40.88	109.92
1983	67.76	18.32	23.84	42.16	109.92	66.28	21.16	19.32	40.48	106.76
1984	66.39	18.61	23.84	42.45	108.84	64.41	20.95	19.12	40.07	104.47
1985	64.99	18.89	23.94	42.83	107.82	62.75	20.74	19.06	39.80	102.54
1988	60.56	19.67	24.76	44.43	105.00	58.38	20.20	19.31	39.51	97.89
1990	59.09	20.25	25.88	46.13	105.22	56.25	19.91	19.68	39.59	95.84
1995	58.08	22.08	28.90	50.98	109.06	53.91	19.75	20.91	40.66	94.56
2000	58.93	24.30	31.75	56.05	114.98	53.68	20.64	22.38	43.02	96.70

TABLE 3-3

PASSENGER CAR AND LIGHT TRUCK FUEL CONSUMPTION BY FUEL TYPE*
(billion gallons)

	October 1984 Output				Tenth Quarterly Report			
		Gasoline				Gasoline		
Year	Diesel	Leaded	Unleaded	Total	Diesel	Leaded	Unleaded	Total
1980	0.53	38.33	50.22	89.08	0.59	43.95	49.95	94.49
1981	0.84	35.18	52.49	88.52	0.97	40.87	52.21	93.99
1982	1.03	32.53	54.20	87.76	1.07	35.89	53.14	90.10
1983	1.13	28.67	56.28	86.08	1.52	31.56	54.73	87.44
1984	1.12	24.85	59.03	85.00	1.37	27.29	56.69	85.35
1985	1.11	21.52	61.25	83.87	1.69	23.45	58.36	83.49
1988	1.13	14.82	64.28	80.23	2.84	15.58	60.12	78.58
1990	1.17	12.15	66.02	79.34	3.81	12.49	59.87	76.17
1995	1.40	8.65	70.11	80.16	5.68	7.70	60.28	73.67
2000	1.66	7.98	73.58	83.22	6.92	6.24	61.16	74.32

*Passenger cars and light-duty trucks under 8,500 lbs GVW.

TABLE 3-4

HEAVY-DUTY TRUCK FUEL CONSUMPTION BY FUEL TYPE*
(billion gallons)

	October 1984 Output				Tenth Quarterly Report			
		Gasoline				Gasoline		
Year	Diesel	Leaded	Unleaded	Total	Diesel	Leaded	Unleaded	Total
1980	14.00	11.13	0.39	25.52	13.94	6.01	0.16	20.11
1981	14.01	11.18	0.39	25.58	13.95	5.94	0.21	20.10
1982	13.67	10.16	0.39	24.21	13.88	5.74	0.21	19.83
1983	13.81	9.62	0.41	23.84	13.56	5.54	0.22	19.32
1984	14.21	9.16	0.46	23.84	13.47	4.84	0.81	19.12
1985	14.66	8.79	0.49	23.94	13.50	4.11	1.43	19.14
1988	16.11	7.13	1.52	24.76	14.01	2.55	2.75	19.31
1990	17.31	6.10	2.47	25.88	14.42	1.93	3.33	19.68
1995	20.15	4.69	4.06	28.90	15.69	0.96	4.24	20.79
2000	22.56	4.26	4.93	31.75	17.03	0.51	4.84	22.37

*All heavy-duty vehicles over 8,500 lbs GVW.

- Updated the estimates of passenger car survival rates based on work performed by Oak Ridge National Lab(30)
- Revised the new vehicle sales forecast based on recent projections obtained from Data Resources, Inc. (DRI)
- Revised the historical input data on sales, fuel economy, annual miles/vehicle by vintage, and diesel penetration for heavy-duty trucks to reflect the new classification scheme outlined above
- Updated forecasts of new vehicle fuel economy and diesel penetration by vehicle class based on new information concerning manufacturer product plans and lower fuel price trajectories
- Revised the estimates of shortfall between the EPA-measured and the on-road fuel economy of new cars and light trucks and incorporated new assumptions concerning trends in the diesel to gasoline EPA-measured fuel economy advantage
- Calibrated the model to 1982 statistics on cars and trucks in operation and total fuel consumption
- Updated estimates of the future growth in annual average miles per vehicle based on the revised estimates of fuel economy and the revised assumptions concerning future fuel price trajectories
- Incorporated revised estimates of misfueling rates by vintage and discretionary fuel switching by model year drawn from recent work done for the Environmental Protection Agency(27)
- Added an off-highway gasoline component to the model
- Revised the projections of the fraction of heavy-duty gasoline trucks that are designed for use on leaded gasoline based on the following assumption: all trucks between 8,500 lbs and 14,000 lbs GVW produced in MY 1987 and later will be equipped with catalytic converters (and therefore use unleaded gasoline) in order to meet EPA HC and CO exhaust emission standards; gasoline trucks over 14,000 lbs GVW will continue to be non-catalyst and use leaded gasoline

As noted above, a large number of changes have been made to the input data files and structure of the MFC model. As shown in Table 3-5, the revisions produce a 5.2 percent (5.3 billion gallon) increase in total highway fuel demand in 1985 and a 15.3 percent (14.5 billion gallon) increase by 1995 relative to the Tenth Quarterly Report.

TABLE 3-5

COMPARISON OF CURRENT OUTPUT WITH THE TENTH QUARTERLY REPORT
(billion gallons)

Year	Vehicle Category	Tenth Quarterly Report	Incremental Effect Of: Revised Shortfall	Revised Calibration	Revised Survival Rates	Revised Growth in VMT/Vehicle	Revised Sales	Revised MPG and VMT by Vintage*	October 1984 Output
1985	Passenger Cars	62.748	+0.185	+0.906	-2.332	+0.065	+0.326	+3.089	64.987
	Light Trucks	20.745	-0.706	+2.057	0.000	+0.113	+0.503	-3.820	18.892
	Heavy-Duty Vehicles	19.043	0.000	-1.400	0.000	-0.631	+0.655	+6.278	23.945
	TOTAL	102.536	-0.521	+1.563	-2.332	-0.453	+1.484	+5.546	107.823
1990	Passenger Cars	56.254	+0.896	+1.014	-2.388	-0.088	-0.580	+3.983	59.091
	Light Trucks	19.913	-0.465	+2.234	0.000	+0.221	+1.225	-2.874	20.254
	Heavy-Duty Vehicles	19.678	0.000	-1.493	0.000	-2.349	+1.657	+8.383	25.875
	TOTAL	95.845	-0.431	+1.755	-2.388	-2.216	+2.302	+9.491	105.219
1995	Passenger Cars	53.911	+1.475	+0.917	-2.512	-0.232	-0.830	+5.351	58.080
	Light Trucks	19.754	-0.059	+2.445	0.000	+0.348	+2.097	-2.508	22.077
	Heavy-Duty Vehicles	20.846	0.000	-1.655	0.000	-4.643	+2.864	+11.490	28.902
	TOTAL	94.561	+1.416	+1.707	-2.512	-4.527	+4.131	+14.333	109.059

*This includes revised projections of EPA mpg for new cars and LDT's under 8,500 lbs GVW, revised projections of on-road mpg for new heavy-duty vehicles, and revised estimates of average annual VMT per vehicle by vintage for heavy-duty trucks.

Time and space limitations do not permit a detailed assessment of the incremental fuel consumption impacts of each of the revisions listed above. Nevertheless, Table 3-5 does illustrate the individual impacts of several of the more important changes in the input data. For example, changes in the EPA-to-on-road fuel economy shortfall relations initially decreased fuel consumption by 0.52 billion gallons in 1985 and then increased consumption by 1.42 billion gallons in 1995 relative to the Tenth Quarterly Report due to differential impacts on car versus light truck on-road fuel economy trends. Calibrating the model to 1982 statistics on fuel use and vehicles in operation instead of 1981 data also increased projections of annual fuel demand by about 1.6-1.8 billion gallons.

The light-duty and heavy-duty truck sales trajectory through 1995 has been increased and the car sales projection has been reduced based on recent forecasts made available from DRI. The result is a 4.1 billion gallon rise in total 1995 fuel consumption relative to the Tenth Quarterly Report. (See Table 3-5.)

The change which has perhaps had the most significant impact on the fuel consumption output has been the reclassification of heavy-duty vehicles. This reclassification of heavy-duty vehicles was undertaken in order to create categories which were more homogeneous with respect to travel and technology characteristics. Data describing the average annual VMT, fuel economy, and stock by vintage and fuel type were drawn from the 1977 Truck Inventory and Use Survey. Due to limitations in the available data, it was necessary to estimate historical trends in sales of trucks over 50,000 lbs GVW and sales of trucks between 8,500 and 10,000 lbs GVW. Furthermore, data limitations forced the use of identical survival rates for all trucks over 14,000 lbs GVW. (Light-heavy trucks

were assumed to have the same survival rate characteristics as light-duty trucks.) For these reasons, the mpg and VMT distribution of the total heavy truck stock by vintage was significantly different than that of the Tenth Quarterly Report -- contributing an 11.5 billion increase in total highway fuel consumption in 1995.

Diesel penetration of new cars and light trucks in 1995 has been reduced from 12.6 percent in the Tenth Quarterly Report to 2.9 percent in the current output. This reduces the diesel share of total cars and light trucks in operation from 9.6 percent to 2.3 percent and contributes to the 4.3 billion gallon (75 percent) drop in 1995 automobile and light-duty truck diesel demand in the current model output relative to the Tenth Quarterly Report (see Table 3-3). The effect of this drop on total diesel fuel demand was, however, negated by the increase in heavy-duty diesel fuel consumption which occurred largely as a result of the changes in the input data on travel and fuel economy that were discussed above. (See Table 3-4).

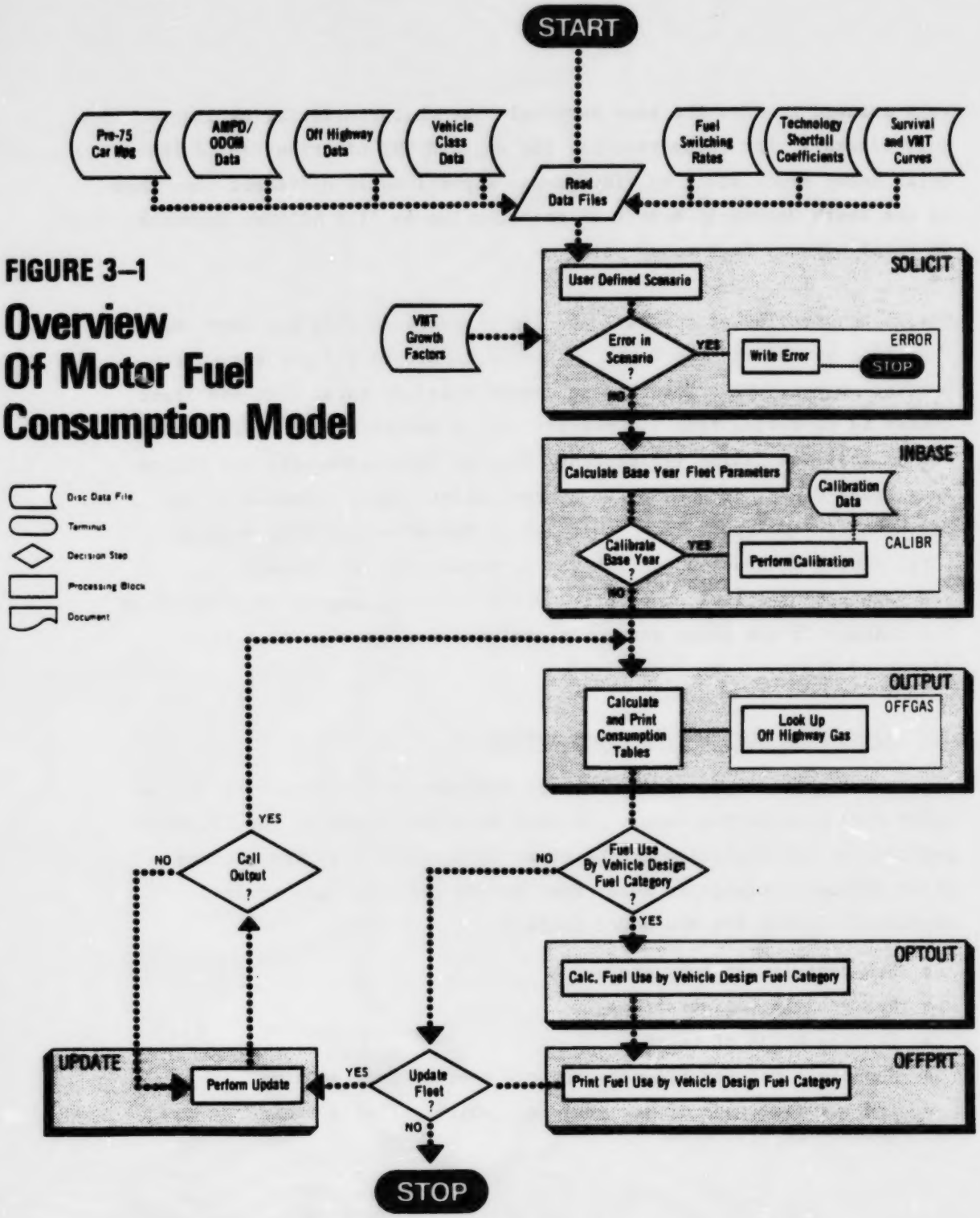
3.3 MOTOR FUEL CONSUMPTION MODEL INPUTS

Figure 3-1 presents a brief schematic overview of the structure of the Motor Fuel Consumption model. (A more detailed review of the MFC model methodology and operation can be found in Appendix A.) Key factors which influence trends in motor fuel demand and which are treated explicitly within the MFC model include:

- New vehicle EPA fuel economy
- New vehicle registrations
- Vehicle miles of travel
- Shortfall between EPA-measured and on-road fuel economy
- The survival rate of new vehicles, which reflects their retirement over time

FIGURE 3–1

Overview Of Motor Fuel Consumption Model



- Other factors
  - fuel switching
  - AMPD/Odometer effect
  - off-highway gasoline consumption

Recent modifications of the model input data on each of the above mentioned factors are presented in the subsections which follow.

3.3.1 New Vehicle Fuel Economy

The new vehicle EPA fuel economy values currently used in the model are shown in Table 3-6. The values through 1984 are based on data published by EPA and on the Corporate Average Fuel Economy (CAFE) values provided from the U.S. Department of Transportation (DOT)(13,14,41).* Projections of passenger car EPA fuel economy through 1995 are drawn from a detailed analysis of automotive fuel economy technologies, manufacturer tooling plans, technology cost-effectiveness and market penetration which is both manufacturer and size-class specific(15). The current forecast assumes that gasoline prices remain constant at 1983 levels through 1985 and then rise at about 1.1 percent annually thereafter. This assumption is based on our assessment of fuel price forecasts prepared by petroleum refiners and the U.S. Energy Information Administration(16).

As shown in Table 3-5, new domestic car EPA fuel economy has been reduced by 1.2 mpg (to 25.9 mpg) in 1985, and by 2.4 mpg (to 35.8 mpg) in 1995 as a result of lowered estimates of diesel penetration,

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*The DOT and EPA data are based on model year statistics. The EPA estimates for 1983 and 1984 are derived from manufacturer projected sales volumes, whereas the DOT figures represent final (for MY 1983) or mid-model year (for MY 1984) CAFE values. In this report the MY 1982-1985 CAFE estimates have been adjusted to account for the introduction of mid-model year vehicles that are labeled as belonging to the next (upcoming) model year (e.g., the Ford Tempo/Topaz was introduced in the spring of 1983 as an MY 1984 vehilce).

TABLE 3-6

NEW VEHICLE EPA MPG*

Vehicle Category	1981	1982	1983	1984	1985	1990	1995	2000
Domestic Cars	23.5 (24.0)	24.6 (25.9)	24.3 (25.7)	25.2 (26.4)	25.9 (27.1)	32.0 (33.9)	35.8 (38.2)	35.8 (38.2)
Imported Cars	30.6 (30.2)	30.6 (30.6)	31.6 (32.3)	31.2 (33.7)	32.4 (35.1)	36.3 (42.7)	39.1 (46.8)	39.1 (46.8)
Domestic Light Trucks 0-8,500 lbs GVW	18.3 (18.0)	19.2 (18.9)	19.6 (18.8)	19.3 (20.7)	20.3 (21.8)	23.7 (26.2)	26.3 (28.5)	26.3 (28.5)
Import Light Trucks 0-8,500 lbs GVW	27.4 (27.4)	27.0 (27.8)	27.1 (28.1)	26.8 (28.6)	27.3 (29.0)	29.8 (31.7)	32.5 (34.5)	32.5 (34.5)
Heavy-Duty Vehicles**/+ greater than 8,500 lbs	7.1 (5.8)	7.6 (6.0)	7.7 (6.1)	7.9 (6.2)	8.0 (6.4)	8.6 (7.2)	9.8 (7.3)	10.3 (7.3)

*Numbers in parentheses represent Tenth Quarterly Report estimates.

**Fuel economy estimates for trucks greater than 8,500 lbs GVW are on-road values.

+Tenth Quarterly Report estimates are for trucks over 10,000 lbs GVW.

announced changes in manufacturer product introduction dates, and a deceleration in the expected fuel price trajectory. The EPA fuel economy of new imported cars has been lowered by 2.7 mpg (to 32.4 mpg) in 1985, and by 7.7 mpg (to 39.1 mpg) in 1995. These revisions reflect changes in import car diesel penetration, manufacturer technology introduction plans under a low fuel price scenario, and a continuation of recent trends in "upsizing" of import car models.

Our analysis of the post-1995 period for cars is not complete. For the purpose of this report, post-1995 passenger car mpg is held constant at 1995 levels.

Forecasts of light truck EPA mpg are drawn from an analysis of technology introduction and penetration by market class and manufacturer. The projections also are based on detailed manufacturer light-duty truck (LDT) product plans through 1987(15). These estimates have recently been revised to account for reduced growth in diesel penetration under a low fuel price scenario. As illustrated in Table 3-5, the fuel economy of domestic LDTs (0-8,500 lbs GVW) will reach 20.3 mpg by 1985 and 26.3 mpg by 1995. (This is 1.5 mpg and 2.2 mpg below that which was previously forecasted for 1985 and 1995, respectively.) The fuel economy of import LDTs (0-8,500 lbs GVW) will reach 27.3 mpg by 1985 and 32.5 mpg by 1995. (These estimates are 1.7 mpg and 2.0 mpg below the previous forecasts for 1985 and 1995, respectively.)

Estimates of the EPA-measured fuel economy advantage of new diesel-fueled cars and light trucks vis-a-vis gasoline cars and LDTs were provided by EPA. These estimates show that the diesel to gasoline fuel economy advantage for new cars has declined from 1.73 for pre-1976 model years to 1.20 for post-1983 model years. For light-duty trucks, the advantage drops from 1.42 for pre-MY 1979 to 1.30 for post-MY 1983(17).

The fuel economy projections for heavy-duty vehicles (all vehicles over 8,500 lbs GVW) are based on work performed for the Motor Vehicle Manufacturers Association(18). This work evaluated and quantified manufacturer plans for the introduction of new technologies and the associated impacts on fuel economy by gross vehicle weight category. Heavy-duty truck fuel economy will reach 8.0 mpg in 1985 and 9.8 mpg by 1995 as a result of continued improvements in diesel engine technology and shifts in sales by weight class. These estimates also account for the effect of the EPA CO and HC exhaust emission regulations for 1987 and later heavy-duty trucks which are expected to reduce fuel economy by an average of about 5 percent.

3.3.2 New Vehicle Registrations

Table 3-7 shows projected new vehicle registrations. The 1983 statistics have been updated based upon the most recent data available in Automotive News(33).

The projection of new vehicle registrations is derived from the DRI forecast, "TRENDLONG 0694" that was provided by DOE. This forecast was used in order to remain consistent with other econometric projections of new vehicle sales used within DOE. The DRI projection provides estimates only through 1995. For the purpose of this report, post-1995 sales are assumed to remain at 1995 levels. The forecast shows an increase in car sales from 7.97 million units in 1982 to 10.54 million units in 1984. Sales drop to 10.42 million in 1985 and then grow at an annual rate of 1.5 percent thereafter (through 1995).

According to the DRI forecast, truck sales will increase 76.5 percent from 2.43 million units in 1982 to 4.29 million units by 1985. Sales drop to 4.28 million in 1986 and then grow at an annual rate of 3.3 percent to reach 5.74 million units by 1995.

TABLE 3-7

NEW VEHICLE REGISTRATIONS*

(10^6 units)

Vehicle Category	1981	1982	1983	1985	1990	1995	2000
Domestic Cars	6.18 (6.18)	5.80 (5.76)	6.79 (6.40)	7.90 (8.10)	8.59 (8.90)	8.85 (9.00)	8.85 (9.00)
Imported Cars	2.35 (2.38)	2.22 (2.22)	2.40 (2.30)	2.52 (2.60)	3.11 (3.00)	3.28 (3.30)	3.28 (3.30)
Domestic Light Trucks 0-8,500 lbs GVW	1.21 (1.21)	1.55 (1.55)	2.05 (1.67)	2.97 (2.51)	3.50 (3.06)	3.99 (3.44)	3.99 (3.44)
Imported Light Trucks 0-8,500 lbs GVW	0.49 (0.49)	0.44 (0.39)	0.43 (0.37)	0.56 (0.46)	0.61 (0.53)	0.69 (0.60)	0.69 (0.60)
Heavy-Duty Vehicles greater than 8,500 lbs GVW	0.43 (0.43)	0.49 (0.49)	0.52 (0.46)	0.76 (0.73)	0.94 (0.86)	1.07 (0.96)	1.07 (0.96)

*Numbers in parentheses represent Tenth Quarterly Report estimates.

In comparison with the Tenth Quarterly Report, the current DRI forecast shows a slight drop in new car sales in 1985 (volume will reach 10.4 million units in 1985 instead of the earlier projection of 10.7 million units), but estimates of post-1985 sales remain essentially unchanged. The current DRI total truck forecast shows growth through 1985 with sales estimates of 490,000 units (15.9 percent) more than previously expected. The outlook for 1995 shows sales of 750,000 units (15 percent) more than that indicated in the previous DRI forecast ("TRENDLONG 0583").

3.3.3 Vehicle Miles of Travel

The trend in average annual miles traveled per vehicle is a critical factor influencing highway fuel demand. However, there is a great deal of uncertainty and confusion concerning the direction of recent and future trends. Data on total VMT and information on vehicle registrations obtained from the Federal Highway Administration (FHWA) show that average annual miles per car increased by 1.1 percent between 1982 and 1983(19). This compares with a 3.5 percent growth estimated in an annual survey of car ownership costs by Hertz Corporation(20). A third source of information is the panel survey of monthly travel and fuel purchases of American families conducted by NPD Research, Inc. This source shows a 1 percent increase in average annual miles traveled per family between 1982 and 1983(21). Since the stock of cars per family has stayed roughly constant between 1982 and 1983, this translates into an equivalent 1 percent growth in annual miles/vehicle.

There is then a wide disparity of current results in travel growth rates per vehicle from existing data sources. This makes it difficult to forecast the growth in travel per vehicle. For the 1982-83 time period,

averages of the results of available data sources were used in the MFC model. Annual miles per car grow 1.1 percent, annual miles per light truck increase 0.8 percent, and annual miles for heavy-duty vehicles grow 2.6 percent between 1982 and 1983.

Annual miles traveled per car is forecast to grow at 0.75 percent per year through the end of the century. This growth rate is consistent with current estimates of trends in fuel prices, growth in personal income, and elasticities of VMT to fuel cost-per-mile developed in the literature(22,23). It also represents a slight drop from the 0.8 percent/year growth estimated used in the Tenth Quarterly Report. This is attributable to the lower fleet on-road fuel economy and fuel price (and therefore higher fuel cost/mile) trajectories of the current output vis-a-vis the Tenth Quarterly Report.

Decreases in fuel cost per mile due to lo. growth in fuel prices and continued improvements in fuel economy are expected to boost annual miles per light-duty truck by an average of 0.5 percent per year over the 1983-2000 time period. As indicated above, available estimates of even recent trends in annual VMT/light truck are highly divergent. Therefore, projections of a long-term growth rate are clouded with uncertainty. Nevertheless, given stable fuel prices in the near term, and continued growth in new light truck sales and fuel economy, the assumption of a 0.5 percent/year increase in average miles traveled per light truck appears reasonable.

Estimates of the growth in average annual miles per vehicle for light-heavy, medium-heavy, and heavy-heavy vehicles are developed using a methodology drawn from work done in support of the U.S. Department of

Transportation Highway Cost Allocation Study(24). That study showed that light-heavy truck annual miles per vehicle will remain relatively constant at 1982 levels through 2000 as diesels expand into trucks used in lower mileage applications and displace relatively older gasoline-fueled vehicles in this category.

Changes in total annual VMT for medium- and heavy-heavy trucks are directly related to changes in economic activity as measured by GNP. The aforementioned study used a total VMT growth estimate of 1.24 percent for every 1 percent increase in real GNP. Using this multiplier in conjunction with DRI forecasts of GNP and the stock estimates produced by the MFC model, medium-heavy truck average annual VMT/vehicle is projected to grow at an average annual rate of 3 percent/year through 2000 while average annual VMT/vehicle for heavy-heavy trucks will remain constant or decline slightly (0.4 percent/year) through 2000. These trends are consistent with the shifting age and diesel composition of the medium-heavy and heavy-heavy truck fleets. For example, the medium-heavy truck (14,000-50,000 lbs GVW) category has been witnessing very high rates of diesel penetration over the past several years particularly in the higher mileage and heavier GVW applications. Although the overall size of this category has been shrinking due to the increasing retirement of large numbers of older and lighter GVW gasoline vehicles, the replacement of these trucks with diesel versions of higher payload capacity is expected to put upward pressure on the growth in annual average VMT per vehicle.

3.3.4 Diesel Penetration

In light of revised fuel price forecasts, the diesel penetration projections for cars, light-duty trucks, and heavy-duty trucks have been reexamined. In general, analysis of the diesel issue revealed that its penetration was sensitive to:

- Absolute fuel prices
- The fuel price differences between gasoline and diesel fuel
- The number of diesel models available

In cars, the penetration seems very sensitive to absolute fuel prices and consumer price expectations. Diesel penetration of all new cars has plunged to 1.5 percent for 1984 compared to nearly 6 percent in 1981. The projection of diesel penetration to 1995 is based on a scenario in which: 1) gasoline prices remain constant at 1983 levels then rise at 1.1 percent/year thereafter through 1995; and 2) diesel fuel prices continue to remain higher than unleaded regular gasoline. Under this scenario, new domestic car diesel penetration will fall to 0.8 percent by 1985 and rise only gradually to 1.5 percent over the following 10 years. This represents a sharp reduction from the 10 percent estimated for 1995 used in the Tenth Quarterly Report. (See Table 3-8.)

Unlike the car market, diesels have been relatively more popular in light trucks. In 1983, for example, domestic LDT diesel penetration was 6.7 percent versus 1.3 percent for domestic cars. However, as with automobiles, the continuation of low gasoline prices and unfavorable diesel versus gasoline price differentials will reduce consumer demand for diesel LDTs and cause manufacturers to postpone and/or cancel plans to expand the number of diesel models available. In the current report, domestic LDT diesel penetration in 1985 has been lowered from 7.4 percent to 1.8 percent. This reflects the cancellation of plans by International Harvester to supply Ford Motor Company with their 6.2 liter diesel engine and is only slightly above the current (MY 1984) low diesel penetration level of 1.4 percent. For 1995, domestic LDT diesel penetration has been reduced from 21 percent to 3.5 percent.

TABLE 3-8

NEW VEHICLE DIESEL PENETRATION*
(Percent)

	Actual			Forecast			
Vehicle Category	1981	1982	1983	1985	1990	1995	2000
Domestic Cars	6.2	3.7	1.3 (1.3)	0.8 (5.6)	1.3 (10.0)	1.5 (10.0)	1.5 (10.0)
Imported Cars	5.3	4.9	4.4 (4.4)	2.6 (4.8)	3.0 (10.0)	4.0 (10.0)	4.0 (10.0)
Domestic Light Trucks 0-8,500 lbs GVW	2.9	5.9	6.7 (6.7)	1.8 (7.4)	2.3 (19.4)	3.5 (21.0)	3.5 (22.6)
Imported Light Trucks 0-8,500 lbs GVW	12.2	12.1	10.5 (12.3)	9.0 (12.5)	10.0 (15.0)	12.0 (18.0)	12.0 (20.0)
Heavy-Duty Vehicles Over 8,500 lbs GVW	31.7	34.8	37.2	41.3	48.0	50.4	50.8

*Numbers in parentheses represent Tenth Quarterly Report estimates.

Due to the relatively high usage levels of heavy-duty vehicles, diesels are expected to continue to be highly cost-effective for this market segment even under a scenario of low fuel prices. Diesel penetration of the heavy-duty truck fleet is expected to reach 41.3 percent in 1985 and 50 percent by 1995.

3.3.5 EPA to On-Road Fuel Economy Shortfall

There is a substantial difference between the fuel economy estimates published by the Environmental Protection Agency and fuel economy achieved on the road. Since the on-road value is almost always lower than the EPA estimate, this difference has been defined as shortfall. Historical experience has shown that it can range from 10 to 25 percent for an average model year. Therefore, the correct quantification of shortfall is extremely important for an accurate forecast of motor fuel consumption.

The current report relies on estimates of shortfall that were recently developed by the U.S. Environmental Protection Agency in support of a proposed rulemaking on fuel economy labeling(25). As shown in Table 3-9, the shortfall estimates employ a gallon-per-mile (gpm) ratio functional form to relate EPA to on-road fuel economy. The relations are specified by model year and fuel system (gasoline versus diesel). Future (post-1984) model year vehicles are assumed to have shortfall characteristics that are identical to those by the 1984 model year relationship.

The shortfall relations provided by EPA were specific to automobiles. Based on work performed by DOE and others, the average gpm ratio shortfall for cars has been measured at 1.18. The average gpm ratio*

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*gpm ratio = ratio of on-road gallons/mile to EPA-measured gallons/mile.

TABLE 3-9

REVISED ESTIMATES OF FUEL ECONOMY SHORTFALL*

Model Year	Passenger Cars	Light Trucks
	All Gasoline-Fueled	All Gasoline-Fueled
1975	OR = EPA/0.0059EPA + 1.066	OR = EPA/0.0059EPA + 1.116
1976	OR = EPA/0.0059EPA + 1.070	OR = EPA/0.0059EPA + 1.120
1977	OR = EPA/0.0059EPA + 1.070	OR = EPA/0.0059EPA + 1.120
1978	OR = EPA/0.0059EPA + 1.062	OR = EPA/0.0059EPA + 1.112
1979	OR = EPA/0.0059EPA + 1.059	OR = EPA/0.0059EPA + 1.109
1980	OR = EPA/0.0059EPA + 1.034	OR = EPA/0.0059EPA + 1.084
1981	OR = EPA/0.0059EPA + 1.027	OR = EPA/0.0059EPA + 1.077
1982	OR = EPA/0.0059EPA + 1.013	OR = EPA/0.0059EPA + 1.063
1983	OR = EPA/0.0059EPA + 1.009	OR = EPA/0.0059EPA + 1.059
1984	OR = EPA/0.0059EPA + 1.001	OR = EPA/0.0059EPA + 1.051
	All Diesel-Fueled	All Diesel-Fueled
1975	OR = EPA/0.0059EPA + 0.894	OR = EPA/0.0059EPA + 0.944
1976	OR = EPA/0.0059EPA + 0.909	OR = EPA/0.0059EPA + 0.959
1977	OR = EPA/0.0059EPA + 0.858	OR = EPA/0.0059EPA + 0.908
1978	OR = EPA/0.0059EPA + 0.884	OR = EPA/0.0059EPA + 0.934
1979	OR = ?A/0.0059EPA + 0.919	OR = EPA/0.0059EPA + 0.969
1980	OR = EPA/0.0059EPA + 0.894	OR = EPA/0.0059EPA + 0.944
1981	OR = EPA/0.0059EPA + 0.908	OR = EPA/0.0059EPA + 0.958
1982	OR = EPA/0.0059EPA + 0.912	OR = EPA/0.0059EPA + 0.962
1983	OR = EPA/0.0059EPA + 0.910	OR = EPA/0.0059EPA + 0.960
1984	OR = EPA/0.0059EPA + 0.878	OR = EPA/0.0059EPA + 0.928

SOURCE: Reference No. 25.

* OR = On-road fuel economy.
EPA = EPA-rated fuel economy.

shortfall for light trucks of an equivalent model year has been measured at 1.22(38,39). Therefore, the EPA shortfall relations for automobiles were adjusted by adding 0.05 to the intercept term (see Table 3-9) in order to arrive at on-road fuel economy estimates for light-duty trucks.

Table 3-10 presents the shortfall relations that were used in the Tenth Quarterly Report. These relations were developed over a year ago and are therefore not as "up-to-date" as those generated by the EPA. A comparison of Tables 3-9 and 3-10 shows that the most obvious change between the two reports has been a reduction in the number of technology categories and an expansion in the number of model years for which shortfall relations have been specified.

Table 3-11 compares the aggregated levels of shortfall by vehicle category from the current model output versus the Tenth Quarterly Report. Domestic and imported cars have higher shortfall at lower EPA fuel economy levels in the current output than in the Tenth Quarterly Report. In contrast, the shortfall of domestic LDTs is almost consistently lower in the current model output vis-a-vis the Tenth Quarterly Report (except at the high EPA fuel economy levels of 1995 and beyond). These differences caused the overall increase in passenger fuel consumption and decrease in LDT fuel use relative to the Tenth Quarterly Report that was shown earlier in Table 3-5.

3.3.6 Other Factors

Other factors which influence trends in the mix and level of motor gasoline consumption include: 1) the frequency of fuel switching by consumers, 2) changes in vehicle fuel economy as a function of vehicle age, and 3) trends in off-highway gasoline demand. The discussion which follows briefly summarizes the input data on these factors.

TABLE 3-10

ESTIMATES OF FUEL ECONOMY SHORTFALL
TENTH QUARTERLY REPORT

Vehicle Category	Passenger Cars	Light Trucks
Conventional* - Automatic Transmission		
Pre-1979	OR** = EPA+/(0.013 EPA + 0.97)	OR = EPA/(1.22)
1979-2000	OR = EPA/(0.013 EPA + 0.91)	OR = EPA/(1.22)
Conventional - Manual Transmission		
Pre-1979	OR = EPA/(0.006 EPA + 1.02)	OR = EPA/(-0.007 EPA + 1.36)
1979-2000	OR = EPA/(0.013 EPA + 0.80)	OR = EPA/(-0.007 EPA + 1.36)
Gasoline-Fueled Front-Wheel Drive		
Pre-1979	OR = EPA/(1.10)	OR = EPA/(1.10)
1979-2000	OR = EPA/(0.004 EPA + 0.99)	OR = EPA/(0.004 EPA + 0.99)
Diesel Rear-Wheel Drive		
All years	OR = EPA/(1.13)	OR = EPA/(1.13)
Diesel Fron-Wheel Drive		
All years	OR = EPA/(1.12)	OR = EPA/(1.12)

*Conventional carburetted, rear-wheel drive vehicle.

**OR = on-road fuel economy.

+EPA = EPA-rated fuel economy.

TABLE 3-11

COMPARISON OF NEW VEHICLE EPA VERSUS
ON-ROAD MPG FOR SELECTED YEARS

	Current Output			Tenth Quarterly Report	
Vehicle Category	EPA MPG	On-Road MPG*	Percent Shortfall	On-Road MPG**	Percent Shortfall
Domestic Cars					
1980	22.0	19.0	-13.6	19.1	-13.2
1985	25.9	22.5	-13.4	22.7	-12.4
1990	32.0	26.9	-15.9	28.0	-12.5
1995-2000	35.8	29.6	-17.3	30.8	-14.0
Imported Cars					
1980	28.7	23.9	-16.7	24.6	-14.3
1985	32.4	27.2	-16.0	27.3	-15.7
1990	36.3	30.0	-17.4	30.4	-16.3
1995-2000	39.1	31.8	-18.7	32.3	-17.4
Domestic Light Trucks					
1980	16.8	14.2	-15.5	13.8	-17.9
1985	20.3	17.4	-14.4	16.8	-17.3
1990	23.7	19.9	-16.0	19.8	-16.5
1995-2000	26.3	21.9	-16.8	22.9	-15.7
Import Light Trucks					
1980	24.3	19.8	-18.5	20.4	-16.0
1985	27.3	22.7	-16.9	23.2	-15.0
1990	29.8	24.5	-17.9	25.7	-13.8
1995-2000	32.5	26.4	-18.8	28.4	-12.6

*$\frac{\text{On-Road MPG}}{\text{EPA MPG}} - 1 \times 100 =$ percent shortfall.

**For the purpose of comparison, on-road mpg has been evaluated at the EPA mpg values used in the current output of the model. See Appendix B for the actual EPA and on-road mpg values shown in the current MFC model output.

3.3.6.1 Fuel Switching

As part of an effort to improve the accuracy of the MFC model in forecasting leaded versus unleaded gasoline, data on trends in passenger car and truck fuel switching by consumers were incorporated into the MFC model.* Fuel switching is a generic term which includes the following:

- Misfuelers are catalyst-equipped vehicles required by the EPA to be fueled with unleaded gasoline which are operated entirely or occasionally on leaded gasoline. The misfueling rate is the percentage of the total gallons consumed by these vehicles that is leaded fuel. Misfueling as used in this report is therefore a gasoline volume-based rate and not an incidence-based rate. (Incidence refers to the percentage of unleaded certified vehicles which use leaded gasoline at some point during the calendar year.)**
- Discretionary switchers are non-catalyst equipped vehicles normally operated on leaded fuel which are operated entirely or occasionally on unleaded gasoline. The discretionary switching rate is the percentage of total gallons consumed by these vehicles which is unleaded fuel. This form of fuel switching does not have deleterious emissions impacts since the vehicles' emission control systems are designed for fuels containing lead.

The data on fuel switching were originally derived from an analysis for DOE of two large survey data bases that contained diary records of consumer fuel purchases and travel behavior for the time period 1978 through 1981.(26) This analysis showed a growth in misfueling that was

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*No fuel switching was assumed for heavy-duty trucks over 14,000 lbs GVW. These vehicles are not catalyst-equipped and are therefore not required to use unleaded gasoline.

**See Appendix D and Reference Nos. 27 and 40 for a more complete discussion of vehicle "incidence" versus "volume"-based fuel swithcing.

linked primarily to the aging of the fleet of catalyst-equipped vehicles. This study was recently updated for EPA with estimates of fuel switching derived from 1982 diary records of consumer fuel purchase and travel behavior(27).*

The revised data used in the MFC model to assess the impact of fuel switching on leaded and unleaded gasoline demand are shown in Table 3-12. The discretionary switching rates are model year specific and are held constant from 1975 to 2000. (The reader should note that this assumption has only marginal impact on the leaded versus unleaded gasoline split since almost all post-1975 passenger cars are catalyst-equipped.) The misfueling rates are vintage dependent, but are held constant for vehicles older than 8 years, since data were available on only eight vintages of catalyst-equipped vehicles. Furthermore, the projections are the same for cars and trucks under 14,000 lbs GVW since the data are not sufficient to develop separate estimates of misfueling by vehicle category and vintage. Table 3-13 compares the leaded gasoline demand impact of the revised fuel switching rates vis-a-vis those used in the Tenth Quarterly Report. The impact of the revised estimates is minimal -- amounting to a 1.6 percent (0.22 billion gallons) increase in leaded gasoline by 1995.

3.3.6.2 AMPD/Odometer Effect

In the development of fuel demand forecasts it is important to account for those factors which influence fuel economy levels over the life of a vehicle. Engineering and statistical analyses have demonstrated that fuel economy typically increases during the interval between the initiation of vehicle operation under cold start conditions and the attainment

*For a more detailed summary of the derivation of the fuel switching rates, the reader should consult Reference No. 27.

TABLE 3-12

FUEL SWITCHING RATES
BY MODEL YEAR AND VINTAGE*
(Percent)

Discretionary Switching**		Misfueling Rates**	
Model Year		Age	
1946	15.4	30	16.1
1947	15.4	29	16.1
1948	15.4	28	16.1
1949	15.4	27	16.1
1950	15.4	26	16.1
1951	15.4	25	16.1
1952	15.4	24	16.1
1953	15.4	23	16.1
1954	15.4	22	16.1
1955	15.4	21	16.1
1956	15.4	20	16.1
1957	15.4	19	16.1
1958	15.4	18	16.1
1959	15.4	17	16.1
1960	15.4	16	16.1
1961	15.4	15	16.1
1962	15.4	14	16.1
1963	15.4	13	16.1
1964	12.2	12	16.1
1965	10.3	11	16.1
1966	12.2	10	16.1
1967	9.4	9	16.1
1968	11.0	8	16.1
1969	11.0	7	13.2
1970	9.8	6	12.7
1971	6.4	5	9.2
1972	9.0	4	5.5
1973	8.7	3	4.2
1974	9.6	2	2.8
1975-2000	27.6	1	3.0

*For cars and trucks less than 14,000 lbs GVW.

**These are "volume-based" fuel switching rates.

TABLE 3-13

IMPACT OF REVISED FUEL SWITCHING RATES
ON HIGHWAY LEADED GASOLINE DEMAND
(billion gallons)

Year	Total Highway Gasoline Use (October 1984 Output)	Case A Leaded Gasoline	Case B Leaded Gasoline
1985	92.05	30.31	31.72
1988	87.76	21.95	22.68
1990	86.74	18.25	18.69
1995	87.50	13.34	13.11
2000	90.76	12.25	11.75

Case A: Fuel switching rates as listed in Table 3-12.

Case B: Fuel switching rates as specified in the Tenth Quarterly Report.

of normal operating temperatures. The increase is a function of both ambient temperature and the distance traveled (i.e., average miles per day or AMPD). The analyses also showed that the sensitivity of fuel economy to average daily travel decreased at higher average AMPD's and increased with vehicle age.

Studies by the EPA have demonstrated the improvement in fuel economy with increasing odometer mileage. This effect is associated with the progressive reduction of internal engine/drivetrain friction which usually occurs during the "breaking-in" period of a new model.

To incorporate these effects into the MFC model, equations which relate in-use fuel economy to odometer mileage and AMPD were drawn from recent EPA and DOE studies. These equations were combined with MFC model input data on annual miles/car by vintage and were used to generate an age-based index of the sensitivity of in-use fuel economy to both increasing odometer and changes in AMPD(28). As shown in Table 3-14, these two effects reduce the in-use fuel economy of a 10-year old vehicle by more than 8 percent relative to its fuel economy when new. This relationship is more fully discussed in Reference No. 37.

3.3.6.3 Off-Highway Gasoline

To facilitate an analysis of the total leaded gasoline market and to enable users to compare projections of total gasoline demand, an off-highway gasoline component was incorporated into the MFC model structure.* The methodology for estimating future trends in off-highway

*Initial consideration also was given to the inclusion of an off-highway diesel component in the MFC model. However, given the level of resources that would have been required to do a detailed analysis of an area in which the available data were not wholly adequate nor consistent, that effort was ultimately judged to be beyond the scope and resources of the current study.

TABLE 3-14

PASSENGER CAR AMPD/ODOMETER FACTOR
FOR IN-USE FUEL ECONOMY

Age	AMPD Factor	Odometer Factor	Combined AMPD/ODOM Factor*
1	1.000	1.013	1.013
2	0.982	1.033	1.014
3	0.965	1.041	1.005
4	0.953	1.047	0.997
5	0.946	1.051	0.994
6	0.941	1.054	0.992
7	0.915	1.056	0.967
8	0.922	1.058	0.976
9	0.899	1.060	0.954
10	0.884	1.062	0.939
11	0.880	1.063	0.935
12	0.855	1.064	0.918
13	0.841	1.065	0.917
14	0.842	1.066	0.910
15	0.859	1.067	0.898
16	0.860	1.068	0.896
17	0.885	1.069	0.862
18	0.775	1.069	0.829
19	0.753	1.070	0.805
20	0.745	1.070	0.800

*The "combined" AMPD/ODOM factor is the product of the individual AMPD and odometer factors by vehicle age. The combined values for 13+ year old vehicles have been "smoothed" to represent a gradual deceleration in the decline in fuel economy with increasing age.

gasoline demand was limited by the fact that available sources of historical data were few in number and often provided estimates which were inconsistent and/or incomplete.* For the purpose of this analysis, historical estimates of off-highway gasoline consumption were derived from the annual editions of Highway Statistics published by the U.S. Federal Highway Administration(35).

Table 3-15 shows historical trends in off-highway gasoline consumption from 1970 to 1982 for four categories of off-highway applications: agriculture, industrial/commercial, construction, and marine/recreational/other. These categories correspond to those used by the Federal Highway Administration with one exception. Marine/recreational/other also includes gasoline consumed by publicly owned vehicles and motorcycles. Total off-highway gasoline use declined from 3.8 billion gallons in 1970 to 3.3 billion gallons in 1982. The shares of total off-highway gasoline attributable to different applications also have shifted over time due largely to variation in the rates of technology penetration by sector. For example, the increasing dieselization of agricultural machinery has been a primary factor behind the decline in agricultural share of total off-highway gasoline consumption from 44 percent in 1970 to 28 percent in 1982. To account for the differences in technology mix and activity levels in the various off-highway sectors, estimates of the future annual growth (decline) in gasoline use were developed for each of the four categories shown in Table 3-15.

Data on the historical leaded share of off-highway gasoline demand for each of the four could not be located in the literature. Through conversations with trade associations and manufacturers, and analysis of

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*See Reference Nos. 29 and 31 for a description of data sources and problems with available estimates of off-highway gasoline usage.

TABLE 3-15

OFF-HIGHWAY GASOLINE USE
(billion gallons)

	Agriculture		Industrial/ Commercial		Construction		Marine/ Recreational	
Year	Total	Lead Fraction	Total	Lead Fraction	Total	Lead Fraction	Total	Lead Fraction
1970	1.932	1.00	0.308	1.00	0.149	1.00	1.436	1.00
1971	1.865	1.00	0.294	1.00	0.127	1.00	1.627	1.00
1972	1.698	1.00	0.312	1.00	0.115	1.00	1.741	1.00
1973	1.750	1.00	0.270	1.00	0.103	1.00	1.815	1.00
1974	1.606	1.00	0.209	1.00	0.111	1.00	1.804	1.00
1975	1.565	1.00	0.179	1.00	0.090	1.00	1.890	0.96
1976	1.472	1.00	0.178	1.00	0.103	1.00	1.993	0.92
1977	1.360	1.00	0.182	1.00	0.085	1.00	2.038	0.88
1978	1.229	1.00	0.175	1.00	0.075	1.00	2.214	0.84
1979	1.152	1.00	0.133	1.00	0.088	1.00	2.251	0.79
1980	1.059	1.00	0.188	1.00	0.149	1.00	2.295	0.75
1981	1.010	1.00	0.171	1.00	0.133	1.00	1.960	0.71
1982	0.912	1.00	0.167	1.00	0.110	1.00	2.070	0.67
1983	0.867	1.00	0.159	1.00	0.104	1.00	2.122	0.65
1984	0.825	1.00	0.151	1.00	0.098	1.00	2.175	0.63
1985	0.784	1.00	0.143	1.00	0.093	1.00	2.229	0.62
1986	0.746	1.00	0.136	1.00	0.087	1.00	2.285	0.60
1987	0.709	1.00	0.129	1.00	0.082	1.00	2.342	0.58
1988	0.675	1.00	0.123	1.00	0.078	1.00	2.401	0.57
1989	0.642	1.00	0.117	1.00	0.073	1.00	2.461	0.56
1990	0.610	1.00	0.111	1.00	0.069	1.00	2.522	0.55
1991	0.580	1.00	0.105	1.00	0.065	1.00	2.585	0.55
1992	0.552	1.00	0.100	1.00	0.061	1.00	2.650	0.55
1993	0.525	1.00	0.095	1.00	0.058	1.00	2.716	0.55
1994	0.499	1.00	0.090	1.00	0.055	1.00	2.784	0.55
1995	0.475	1.00	0.086	1.00	0.052	1.00	2.854	0.55
1996	0.451	1.00	0.081	1.00	0.050	1.00	2.925	0.55
1997	0.429	1.00	0.077	1.00	0.046	1.00	2.998	0.55
1998	0.408	1.00	0.074	1.00	0.044	1.00	3.073	0.55
1999	0.388	1.00	0.070	1.00	0.041	1.00	3.150	0.55
2000	0.369	1.00	0.066	1.00	0.039	1.00	3.228	0.55

SOURCE: Historical (pre-1983) data on total off-highway gasoline by subsector drawn from Reference No. 35. Post-1982 total gasoline consumption by subsector are based on the following 1982-2000 annual growth rates: agriculture (-4.9 percent/year), industrial/commercial (-5.0 percent/year), construction (-5.6 percent/year), and marine/recreational (+2.5 percent/year).

testimony presented at the recent EPA hearings on lead phasedown, information was obtained on the lead lubricity requirements of off-highway farm equipment, construction machinery, recreational boats, and motorcycles(36). Using these data and estimates of the mix of technologies and distribution of engines by size and vintage (when available), leaded gasoline shares were "guesstimated" for each sector. These estimates are also shown in Table 3-15.

4. USE OF THE MODEL

Over the past 12 months, several improvements have been made to the Motor Fuel Consumption model to: 1) facilitate analyses of trends in the total leaded gasoline market, 2) provide updated estimates of the impact of misfueling, and 3) assess the fuel consumption impacts of future fuel economy standards. This section briefly summarizes each of these analyses.

4.1 EVALUATION OF FUEL SAVINGS FROM PROPOSED CHANGES IN CORPORATE AVERAGE FUEL ECONOMY STANDARDS FOR POST-MY 1985 PASSENGER CARS

The Motor Fuel Consumption (MFC) model was recently used to support analysis by the U.S. Department of Energy of the fuel savings impacts of proposed increases in CAFE standards for post-MY 1985 passenger cars.* These proposed standards are as follows:

Model Year	H.R. 5583 Proposed Standards (mpg)
1986	27.5
1989	32.5
1992	38.0
1995+	45.0

This effort did <u>not</u> provide a judgement as to whether the proposed H.R. 5583 standards should be imposed or would be met. It simply compared fuel consumption estimates using the new car fuel economy trajectory currently forecasted as being "cost-effective" to that which might result from imposition of the proposed standards.

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*H.R. 5583, "Automobile Fuel Efficiency Amendments of 1984."

As shown in Table 4-1, if automobile manufacturers achieve a CAFE of 45.0 mpg by 1995 as proposed in the congressional bill, H.R. 5583, total passenger car fuel use would be 3.58 MMB/D. This represents a savings of 0.66 MMB/D relative to a case in which fuel economy does not improve over and above the MY 1986 estimate of 27.5 mpg. However, based on analysis of current manufacturer tooling plans and technology costs, there is significant scope for further cost-effective improvements in fuel economy over MY 1986 levels even under a scenario of low fuel price growth and without CAFE standards. Measured against a scenario of ongoing improvements in fuel economy, the fuel savings from the H.R. 5583 proposed CAFE standards would therefore be significantly reduced. As shown in Table 4-1, fuel savings in 1995 could be as low as 50,000 bbl/day in 1995 if (as is likely) cost-effective fuel economy improvements continue to be implemented in the post-MY 1986 time period.

4.2 ANALYSIS OF TRENDS IN THE MARKET FOR LEADED GASOLINE

As shown in Table 4-2, a total of 45.7 billion gallons of leaded gasoline was consumed in the U.S. in 1982. 42.6 billion gallons were used on the highway, while 2.6 billion gallons were burned in off-highway (i.e., agricultural, construction, industrial, and marine) engines, and the remainder fueled the general aviation aircraft fleet. By 1995, the total leaded gasoline market is expected to shrink by more than 64 percent to 16.2 billion gallons. This drop is primarily attributable to the increasing penetration of cars and light-duty trucks designed to burn unleaded fuel and to the ongoing displacement of heavy-duty gasoline vehicles by diesel-powered versions.

While the overall leaded gasoline market is expected to decline, there will be significant shifts in the market shares of the major users. As shown in Table 4-3, the share of highway vehicles designed for leaded gasoline will drop from 84.2 percent in 1982 to 35.8 percent in 1995 as

TABLE 4-1

ANALYSIS OF TRENDS IN PASSENGER CAR
FUEL USE AND EFFICIENCY

Fuel Consumption (millions of barrels/day)

Year	Base Case*	Flat Case**	Proposed H.R. 5583 Standards	Fuel Savings	
				Case A+	Case B++
1985	4.21	4.21	4.21	0.00	0.00
1990	3.81	4.01	3.82	0.19	0.01
1995	3.63	4.24	3.58	0.66	0.05
2000	3.59	4.51	3.34	1.17	0.25

Fuel Efficiency (new EPA mpg/fleet on-road mpg)

Year	Base Case*	Flat Case**	Proposed H.R. 5583 Standards
1985	27.8/18.7	27.8/18.7	27.8/18.7
1990	35.4/23.4	29.0/22.3	34.1/23.4
1995	39.8/28.0	29.1/24.0	42.9/28.4
2000	39.8/30.9	29.1/24.6	46.2/41.2

*Derived from Tenth Quarterly Report with modifications to account for recently updated estimates of new domestic and import passenger car EPA mpg for 1982-1988. (Note: these estimates are not comparable to those used in the current, October 1984 model output.)

**New domestic and import passenger car fuel economies held constant at the 1986 values through 2000.

+Case A = Flat Case minus Proposed H.R. 5583 standards.

++Case B = Base Case minus Proposed H.R. 5583 standards.

TABLE 4-2

LEADED GASOLINE CONSUMPTION BY MAJOR END-USE CATEGORY
(billion gallons)

	Cars		Trucks Less Than 14,000 lbs GVW+		Trucks Greater Than 14,000 lbs GVW	Total Highway					
Year	Design*	Misfuel**	Design	Misfuel		Design	Misfuel	Total	Off-Highway	General Aviation++	Total All Uses
1982	19.4	3.6	11.8	0.5	7.3	38.5	4.1	42.6	2.6	0.5	45.7
1983	15.9	4.2	10.8	0.7	6.7	33.4	4.9	38.2	2.5	0.4	41.2
1984	12.7	4.5	10.0	0.8	6.0	28.7	5.3	34.0	2.4	0.5	36.9
1985	9.9	4.7	9.3	0.9	5.5	24.7	5.6	30.3	2.4	0.5	33.2
1988	4.8	5.0	6.6	1.3	4.2	15.6	6.3	21.9	2.2	0.5	24.6
1990	3.0	5.1	4.8	1.6	3.8	11.6	6.7	18.3	2.2	0.6	21.1
1995	0.7	5.3	1.7	2.3	3.4	5.8	7.6	13.4	2.2	0.6	16.2

*"Design" refers to vehicles which are designed to operate on leaded gasoline.

**"Misfueled" volumes of gasoline are estimated using the data on misfueling rates by vintage shown earlier in Table 3-12.

+Post-MY 1986 light-heavy gasoline trucks (8,501-14,000 lbs GVW) will be equipped with catalytic converters and required to use unleaded. These vehicles are assumed to misfuel at the same rate as light-duty trucks under 8,500 lbs GVW.

++Drawn from Reference No. 32.

TABLE 4-3

SHARE OF TOTAL LEADED GASOLINE MARKET
BY MAJOR END-USE CATEGORY
(Percent)

		Percent of Total Leaded Gasoline Due to:				
		Highway				
Year	Total Leaded Gasoline (billion gallons)	Design	Mis-fueling	Total	Off-Highway	General Aviation
1982	45.7	84.2	9.0	93.2	5.7	1.1
1985	33.2	74.4	16.9	91.3	7.2	1.5
1988	24.6	63.4	25.6	89.0	9.0	2.0
1990	21.1	55.0	31.8	86.8	10.4	2.8
1995	16.2	35.8	46.9	82.7	13.6	3.7

these vehicles are increasingly scrapped from the fleet through old age and attrition. In contrast, as the fleet of vehicles designed for unleaded continues to expand and age over time, the proportion of leaded gasoline consumption attributable to potential misfuelers will jump from 9.0 percent in 1982 to 46.9 percent by 1995. However, even this significant growth in the share (and volume) of leaded gasoline accounted for by misfuelers will not be sufficient to stem the overall decline in the highway share of the total leaded gasoline market from 93.2 percent in 1982 to 82.6 percent in 1995.

The absolute volume of leaded gasoline consumed in off-highway applications will fall slightly from 2.6 billion gallons in 1982 to 2.2 billion gallons in 1995. This drop translates into a 1.3 percent annual rate of decline which is significantly less than the 8.4 percent yearly shrinkage expected for the highway sector. As a result, the share of total leaded gasoline used in off-highway engines will rise from 5.7 percent in 1982 to 13.6 percent by 1995. Similarly, although the volume of leaded gasoline used in general aviation is expected to remain nearly constant at 0.5-0.6 billion gallons through 1995, the market share of this segment will rise from 1.1 percent in 1982 to 3.7 percent over the following 13 years.

4.3 ASSESSMENT OF CURRENT AND PROJECTED TRENDS IN LIGHT-DUTY VEHICLE FUEL SWITCHING

As indicated earlier in Section 3.3.6, the light-duty vehicle fuel switching rates used in the MFC model were recently updated to incorporate 1982 information on consumer fuel purchasing and travel behavior(27). These data were subsequently used to support comments prepared by the U.S. Department of Energy on the proposed rulemaking issued by the EPA to reduce the lead-content of gasoline.

The fuel switching data used in the October output of the MFC model (shown earlier in Section 3) assume that the percentage of gallons consumed by catalyst vehicles over 8 years of age that represents misfueling remains constant at the eighth year vintage value of 16.1 percent. This assumption was made because only 8 vintage years of data were available in 1982 for the catalyst-equipped fleet of vehicles. However, if the trend of increasing misfueling by vintage observed in the 8 vintage years of data in 1982 were to continue as the catalyst fleet aged in the future, then as much as 59 percent of the gallons consumed by 25 year old catalyst vehicles in the year 2000 could potentially be leaded gasoline.

To bound the range of estimates of the potential impact of misfueling on leaded gasoline demand for the DOE comments on the EPA proposed rulemaking, three cases were analyzed. These included: 1) misfueling rates as shown in Table 3-12 (i.e., held constant for all cars and light trucks over 8 years old at the rate observed for an 8 year old vehicle), 2) misfueling rates extrapolated to 59 percent for vehicles which are 25 years old and older, and 3) no misfueling. (See Figure 4-1.) Table 4-4 illustrates the results.* Depending upon the future growth of misfueling rates with increasing vintage, vehicles which are designed to use unleaded but misfuel will account for 36 to 41 percent of total highway leaded gasoline demand in 1990. Relative to a scenario of no misfueling, the use of leaded gasoline in catalyst-equipped vehicles could boost total highway leaded gasoline consumption by 57 to 70 percent in 1990.

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*The data shown in Table 4-4 have been derived from a new output format developed for the MFC model which readily allows the identification and disaggregation of fuel use (i.e., leaded, unleaded gasoline and diesel fuel) by vehicle design fuel type (i.e., whether the vehicle is designed for leaded, unleaded gasoline or diesel fuel). For the interested reader, a copy of this new output format has been included as Appendix C.

FIGURE 4-1

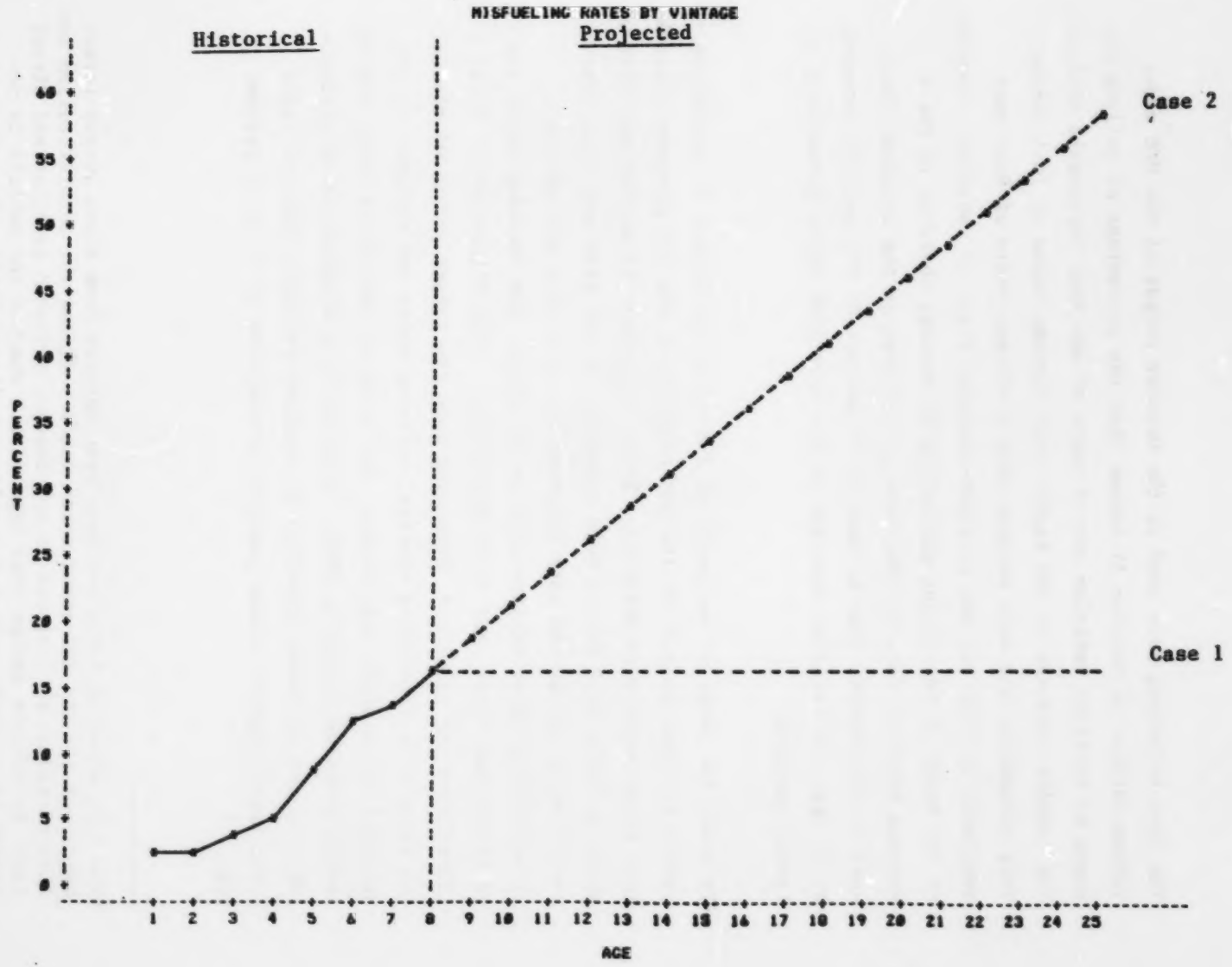
MISFUELING RATES BY VINTAGE
Historical
Projected
Case 2
Case 1
PERCENT
60
55
50
45
40
35
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
AGE

TABLE 4-4

IMPACT OF MISFUELING ON
HIGHWAY LEADED GASOLINE CONSUMPTION
(billion gallons)

Year	No Misfueling	Incremental Impact of Misfueling		Percentage Increase Relative to No Misfueling	
		Case 1*	Case 2**	Case 1	Case 2
1982	38.49	+4.19	+4.19	10.9	10.9
1985	24.68	+5.63	+6.14	22.8	24.9
1988	15.68	+6.27	+7.54	40.1	48.1
1990	11.62	+6.64	+8.21	57.1	70.8
1995	5.71	+7.62	+9.90	133.4	173.4
2000	3.97	+8.28	+11.02	208.6	277.6

*Misfueling rate capped at 16.1 percent for vehicles that are eight years of age and older.

**Misfueling rate extrapolated from 16.1 percent for an eight year old vehicle to 59 percent for vehicles that are 25 years of age and older.

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APPENDIX A

MOTOR FUEL CONSUMPTION MODEL STRUCTURE AND METHODOLOGY

MODEL STRUCTURE

The Motor Fuel Consumption Model estimates annual fuel demand for 1975 through 2000 by calculating two major parameters: annual vehicle miles of travel (VMT) and average on-road fleet fuel economy. The model computes total VMT and fleet mpg through the use of historical data and future estimates for the following variables:

- The annual new vehicle registrations
- The survival rate of new vehicles, which reflects their retirement over time
- The annual VMT per vintage year, which captures the effect of decreasing VMT per vehicle with age
- Annual percentage change in average yearly VMT per vehicle which accounts for the influence of shifting economic and demographic conditions on trends in travel behavior
- The new vehicle average fuel economies as determined through the EPA test procedures
- An on-road mpg discount factor, which accounts for in-use driving conditions and reduces actual fuel economy below the EPA test value*
- A vintage dependent mpg discount factor, which accounts for the influence of increasing odometer (and changes in average daily travel with increasing vehicle age) on fuel economy

The model is designed so that data inputs can vary by vehicle categories. These categories are:

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*EPA has no standardized fuel economy measurement procedures for trucks greater than 8,500 lbs GVW. Therefore, all fuel economy values used in the model for trucks over 8,500 lbs GVW are on-road values.

- Domestic passenger autos
- Import passenger autos
- Domestic light-duty trucks, 0-8,500 lbs GVW
- Import light-duty trucks, 0-8,500 lbs GVW
- Light-heavy-duty vehicles, 8,500-14,000 lbs GVW
- Medium-heavy-duty vehicles, 14,000-50,000 lbs GVW
- Heavy-heavy-duty vehicles, over 50,000 lbs GVW

Since some vehicles operate for up to 30 years (as determined by the survival rate), data from 1946 to the present are required to project the size and composition of the vehicle fleet and compute the annual VMT, fleet fuel economy, and fuel consumption.

Annual highway fuel consumption is calculated for the following fuel types: diesel fuel, leaded gasoline, and unleaded gasoline. This disaggregation assumes a new vehicle diesel penetration rate which varies by vehicle category and year. The leaded/unleaded breakout is obtained from data on the past and future ratio of gasoline engines using leaded fuel to total new gasoline engine registrations.

The model also computes annual off-highway leaded and unleaded gasoline. This calculation is based on historical (1970-1982) data on leaded/unleaded gasoline usage in four sectors (agriculture, construction, industrial/commercial, marine/recreational/other) and user supplied annual growth rates.

The model's output includes for each year and vehicle class:

- Average on-road new vehicle fuel economy
- New vehicle registrations with:
  - spark ignition engines
  - diesel engines

- Average on-road fleet fuel economy
- Fleet vehicle registrations with:
  - spark ignition engines
  - diesel engines
- Total VMT
- Highway fuel consumption disaggregated by:
  - diesel fuel
  - leaded gasoline
  - unleaded gasoline

The output also includes total off-highway gasoline by year disaggregated by leaded and unleaded.

METHODOLOGY

This section briefly describes the sequence of basic calculations used to derive annual fleet fuel consumption estimates. These estimates are derived through mathematical computations involving:

- The age distribution of the vehicle fleet in a given year
- The fuel economy characteristics of that fleet
- The travel characteristics of the in-use fleet, which vary by the age of the vehicles in the fleet

The model's calculations of the total stock of vehicles must account for each year's new purchases in addition to resultant fleet turnover. The procedure used to derive the age distribution of the vehicle fleet:

- takes new registrations for the 30 years preceding the year of the analysis; and
- applies a marginal survival rate which reflects past retirement patterns of vehicles as they age from one year to the next.

The survival rate is based on vehicle age data for a single historical period and does not take into account slight changes in fleet composition which may occur over time. Separate survival rates are utilized for passenger automobiles, light-duty trucks, and heavy-duty vehicles.

The mpg performance of the stock is directly related to the fuel economy and age distribution of the vehicles in use. The model uses fuel economy information for each vintage year to determine the average mpg for the individual categories in the fleet.

Travel characteristics of the fleet are directly related to the age distribution of vehicles and the VMT associated with the age of the vehicle. Travel characteristics are derived by:

- Taking annual VMT per vehicle which varies by age
- Applying it to the stock of in-use vehicles to produce total VMT for the fleet distributed by age
- Adjusting the total to account for year-to-year shifts in annual VMT per average vehicle which are attributable to changes in economic and demographic patterns, etc.

The data on decreasing VMT per vehicle and age differ by vehicle category.* These schedules are shifted over time to account for changes in the growth in the average annual VMT/vehicle.

The actual calculation procedure used to derive fleet VMT, mpg, and fuel consumption in any given year is described below:

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*In addition, the VMT data differ for gasoline versus diesel-fueled heavy-duty trucks.

$$TVMT_j = \sum_t \sum_i \sum_k RG_{ij} \times PCT_{ijt} \times VMT_{kjt} \times SP_{kj} \times VMTADJ_j$$

where: $TVMT_j$ = total VMT per vehicle type j (one of ten categories of motor vehicles)

RG_{ij} = registrations of vehicles in year i and vehicle type j

PCT_{ijt} = percentage of registrations of vehicles in year i and vehicle type j and fuel type t

SP_{kj} = probability of vehicles of age k, vehicle type j, and fuel type t surviving to reach age k+1

VMT_{kjt} = vehicle miles traveled of age k, vehicle type j, and fuel type t

$VMTADJ_j$ = annual growth in VMT per average vehicle type j from year i-1 to year i

$$TFC_t = \sum_i \sum_k \sum_j RG_{ij} \times VMT_{kj} \times VMTADJ_j \times PCT_{ijt}/MPG_{ijt} \times ADJ \times MPGINDEX$$

where: TFC_t = total fuel consumed of type t (leaded, unleaded, diesel)

MPG_{ijt} = MPG of registrations of vehicles in year i and vehicle type j and fuel type t

ADJ = an optional discount factor which adjusts the EPA MPG to an on-road MPG*

MPGINDEX = an optional discount factor which adjusts on-road mpg to account for the influerce of increasing odometer and changes in average daily travel with increasing age**

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*Used only for cars and light-duty trucks less than 8,500 lbs GVW. Fuel economy input data for other vehicle categories are on-road values.

**Used only for automobiles due to data limitations.

$$AMPG_j = TVMT_j / \sum_t \sum_i \sum_k (RG_{ij} \times PCT_{ijt} \times SP_{kj} \times VMT_{kjt} \times VMTADJ_j / MPG_{ijt}$$

where: $AMPG_j$ = average fleet MPG for vehicle type j

The average fleet fuel economy is determined harmonically in order to calculate fuel consumption. The calculation is weighted by both the age distribution of vehicles on the road and their relative VMT. This weighting accounts for the fact that there are relatively fewer older vehicles on the road and those older vehicles are driven relatively less than later model year vehicles.

APPENDIX B

OCTOBER 1984 OUTPUT OF THE MOTOR FUEL CONSUMPTION MODEL

* 1980 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	22.00	18.99	6.163	0.297	16.38	14.89	86.852	0.490	951.60	0.318	23.738	39.867	63.924	4.17
PA IMP	28.70	23.92	2.227	0.073	25.54	21.80	16.882	0.340	206.06	0.150	5.538	3.763	9.451	0.62
TOTAL LDV	23.44	20.07	8.389	0.371	17.49	15.78	103.734	0.830	1157.66	0.469	29.275	43.630	73.374	4.79
TRUCK DOM 0-8.5	16.81	14.25	1.349	0.047	13.14	11.05	25.910	0.126	160.94	0.061	8.655	5.855	14.571	0.95
TRUCK IMP 0-8.5	24.34	19.83	0.520	0.0	22.60	18.22	2.720	0.0	20.76	0.0	0.403	0.736	1.139	0.07
TOTAL LDT	18.35	15.43	1.869	0.047	13.80	11.57	28.630	0.126	181.70	0.061	9.057	6.592	15.710	1.02
TOTAL LDV + LDT	22.71	19.40	10.259	0.417	16.88	15.03	132.365	0.956	1339.36	0.530	38.333	50.222	89.084	5.81
LT HVY TRUCKS	----	10.50	0.302	0.0	----	9.57	2.030	0.000	28.21	0.000	2.562	0.385	2.947	0.19
MED HVY TRUCKS	----	6.59	0.073	0.069	----	5.72	2.898	0.539	71.50	4.080	8.424	0.0	12.504	0.82
HVY HVY TRUCKS	----	5.32	0.0	0.104	----	4.85	0.053	0.990	48.82	9.920	0.146	0.0	10.066	0.66
TOTAL HVY TRUCK	----	6.77	0.375	0.173	----	5.82	4.982	1.530	148.53	14.000	11.132	0.385	25.517	1.66
TOT HWY GAS&DSL	----	16.24	10.634	0.590	----	12.98	137.346	2.486	1487.89	14.530	49.465	50.607	114.601	7.48
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	3.117	0.574	3.691	0.24
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	52.582	51.180	103.762	6.77

* 1981 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	23.50	20.27	5.804	0.386	17.04	15.27	86.408	0.871	941.61	0.544	20.906	40.231	61.682	4.02
PA IMP	30.60	25.45	2.255	0.125	26.43	22.26	18.103	0.457	223.42	0.201	4.934	4.903	10.038	0.65
TOTAL LDV	25.12	21.48	8.059	0.511	18.29	16.24	104.511	1.328	1165.03	0.745	25.840	45.135	71.719	4.68
TRUCK DOM 0-8.5	18.30	15.48	1.173	0.035	13.43	11.29	26.172	0.160	174.89	0.077	8.910	6.431	15.419	1.01
TRUCK IMP 0-8.5	27.40	22.32	0.428	0.059	23.48	18.97	3.891	0.059	26.13	0.022	0.429	0.926	1.377	0.09
TOTAL LDT	20.23	16.97	1.600	0.095	14.22	11.92	29.264	0.220	200.22	0.099	9.339	7.358	16.796	1.10
TOTAL LDV + LDT	24.45	20.85	9.659	0.606	17.55	15.42	133.775	1.548	1365.25	0.844	35.179	52.492	88.515	5.77
LT HVY TRUCKS	----	10.71	0.273	0.001	----	9.77	2.226	0.001	31.41	0.002	2.823	0.391	3.215	0.21
MED HVY TRUCKS	----	6.77	0.061	0.068	----	5.82	2.703	0.573	74.93	4.628	8.236	0.0	12.864	0.84
HVY HVY TRUCKS	----	5.50	0.0	0.086	----	4.93	0.049	1.033	46.82	9.382	0.117	0.0	9.499	0.62
TOTAL HVY TRUCK	----	7.06	0.334	0.155	----	5.99	4.978	1.608	153.16	14.012	11.175	0.391	25.578	1.67
TOT HWY GAS&DSL	----	17.52	9.994	0.760	----	13.31	138.753	3.155	1518.41	14.856	46.354	52.883	114.093	7.44
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.706	0.568	3.274	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	49.060	53.452	102.512	6.69

* 1982 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) LEAD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) UNLD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) TOTAL	MMB/DAY TOTAL
PA DOM	24.60	21.30	5.549	0.211	17.70	15.66	86.072	1.072	924.42	0.619	18.662	39.768	59.049	3.85
PA IMP	30.60	25.72	2.112	0.108	27.10	22.65	19.170	0.554	235.18	0.238	4.399	5.744	10.381	0.68
TOTAL LDV	26.02	22.37	7.661	0.319	19.04	16.70	105.242	1.626	1159.60	0.857	23.061	45.512	69.430	4.53
TRUCK DOM 0-8.5	19.20	16.52	1.458	0.091	13.81	11.63	26.556	0.249	194.15	0.129	9.007	7.555	16.692	1.09
TRUCK IMP 0-8.5	27.00	22.43	0.387	0.053	24.00	19.47	3.407	0.113	31.82	0.046	0.460	1.128	1.634	0.11
TOTAL LDT	20.51	17.54	1.845	0.144	14.69	12.33	29.963	0.362	225.97	0.175	9.467	8.684	18.326	1.20
TOTAL LDV + LDT	24.99	21.46	9.506	0.463	18.16	15.79	135.204	1.987	1385.57	1.032	32.528	54.196	87.756	5.72
LT HVY TRUCKS	----	11.33	0.269	0.052	----	10.04	2.415	0.053	32.88	0.067	2.823	0.386	3.277	0.21
MED HVY TRUCKS	----	6.85	0.053	0.054	----	5.92	2.509	0.593	69.90	4.566	7.234	0.0	11.801	0.77
HVY HVY TRUCKS	----	5.67	0.0	0.066	----	5.00	0.044	1.049	45.68	9.034	0.098	0.0	9.132	0.60
TOTAL HVY TRUCK	----	7.55	0.322	0.172	----	6.13	4.968	1.695	148.46	13.668	10.156	0.386	24.209	1.58
TOT HWY GAS&DSL	----	18.45	9.828	0.635	----	13.70	140.172	3.682	1534.02	14.700	42.684	54.582	111.965	7.30
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.576	0.683	3.259	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	45.260	55.265	100.525	6.56

* 1983 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) LEAD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) UNLD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) TOTAL	MMB/DAY TOTAL
PA DOM	24.30	21.11	6.704	0.088	18.49	16.16	84.869	1.143	921.45	0.607	16.197	40.203	57.007	3.72
PA IMP	31.60	26.52	2.299	0.106	27.87	23.14	20.127	0.643	248.80	0.268	3.898	6.585	10.750	0.70
TOTAL LDV	25.87	22.30	9.003	0.194	19.92	17.27	104.996	1.786	1170.25	0.875	20.095	46.788	67.757	4.42
TRUCK DOM 0-8.5	19.60	16.76	1.891	0.136	14.36	12.11	27.094	0.382	200.99	0.196	8.130	8.268	16.594	1.08
TRUCK IMP 0-8.5	27.10	22.38	0.385	0.045	24.39	19.85	3.698	0.158	34.35	0.059	0.445	1.227	1.731	0.11
TOTAL LDT	20.60	17.53	2.275	0.182	15.27	12.84	30.791	0.540	235.34	0.255	8.575	9.494	18.324	1.20
TOTAL LDV + LDT	24.83	21.35	11.278	0.376	18.95	16.33	135.787	2.325	1405.59	1.130	28.670	56.282	86.082	5.62
LT HVY TRUCKS	----	11.55	0.279	0.063	----	10.30	2.587	0.116	36.01	0.143	2.946	0.408	3.497	0.23
MED HVY TRUCKS	----	7.08	0.047	0.056	----	6.04	2.318	0.613	68.07	4.680	6.594	0.0	11.274	0.74
HVY HVY TRUCKS	----	5.82	0.0	0.074	----	5.09	0.040	1.069	46.15	8.984	0.083	0.0	9.066	0.59
TOTAL HVY TRUCK	----	7.74	0.326	0.193	----	6.30	4.945	1.798	150.23	13.807	9.623	0.408	23.838	1.55
TOT HWY GAS&DSL	----	18.69	11.605	0.568	----	14.15	140.732	4.124	1555.82	14.937	38.292	56.690	109.920	7.17
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.509	0.743	3.252	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	40.801	57.433	98.234	6.41

* 1984 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	25.20	21.93	8.839	0.057	19.46	16.83	84.975	1.172	932.36	0.573	13.769	41.042	55.384	3.61
PA IMP	31.20	26.39	2.374	0.071	28.47	23.53	21.067	0.691	259.07	0.275	3.413	7.321	11.009	0.72
TOTAL LDV	26.38	22.83	10.413	0.128	20.90	17.95	106.042	1.863	1191.43	0.849	17.182	48.364	66.394	4.33
TRUCK DOM 0-8.5	19.30	16.59	2.725	0.042	15.01	12.69	28.422	0.419	212.66	0.194	7.248	9.317	16.759	1.09
TRUCK IMP 0-8.5	26.80	22.32	0.502	0.050	24.83	20.28	4.089	0.206	37.48	0.074	0.422	1.352	1.848	0.12
TOTAL LDT	20.24	17.33	3.228	0.091	15.95	13.44	32.512	0.625	250.14	0.267	7.670	10.670	18.607	1.21
TOTAL LDV + LDT	24.97	21.56	13.641	0.219	19.83	16.96	138.554	2.488	1441.58	1.116	24.851	59.033	85.001	5.54
LT HVY TRUCKS	----	11.77	0.368	0.092	----	10.60	2.840	0.208	40.60	0.241	3.126	0.463	3.831	0.25
MED HVY TRUCKS	----	7.26	0.067	0.082	----	6.21	2.158	0.658	67.39	4.890	5.967	0.0	10.856	0.71
HVY HVY TRUCKS	----	5.98	0.0	0.105	----	5.22	0.035	1.116	47.72	9.081	0.068	0.0	9.149	0.60
TOTAL HVY TRUCK	----	7.87	0.435	0.279	----	6.53	5.033	1.982	155.72	14.212	9.161	0.463	23.837	1.55
TOT HWY GAS&DSL	----	18.50	14.076	0.498	----	14.68	143.586	4.470	1597.30	15.328	34.013	59.497	108.837	7.10
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.444	0.805	3.248	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	36.456	60.301	96.758	6.31

* 1985 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	25.90	22.47	7.834	0.063	20.42	17.51	84.890	1.194	940.58	0.550	11.640	41.537	53.727	3.50
PA IMP	32.40	27.24	2.458	0.066	29.14	23.98	22.009	0.726	269.97	0.277	3.009	7.973	11.259	0.73
TOTAL LDV	27.23	23.46	10.292	0.129	21.88	18.63	106.908	1.921	1210.55	0.828	14.650	49.509	64.987	4.24
TRUCK DOM 0-8.5	20.30	17.37	2.916	0.053	15.73	13.32	29.873	0.466	225.60	0.194	6.467	10.277	16.939	1.10
TRUCK IMP 0-8.5	27.30	22.68	0.508	0.050	25.25	20.68	4.470	0.253	40.39	0.087	0.399	1.467	1.953	0.13
TOTAL LDT	21.16	18.04	3.423	0.104	16.68	14.08	34.342	0.719	266.00	0.281	6.867	11.744	18.892	1.23
TOTAL LDV + LDT	25.79	22.16	13.716	0.232	20.72	17.60	141.242	2.639	1476.55	1.109	21.516	61.253	83.878	5.47
LT HVY TRUCKS	----	12.00	0.376	0.104	----	10.87	3.090	0.309	45.29	0.346	3.331	0.489	4.165	0.27
MED HVY TRUCKS	----	7.44	0.071	0.092	----	6.40	2.011	0.711	67.16	5.089	5.407	0.0	10.496	0.68
HVY HVY TRUCKS	----	6.13	0.0	0.120	----	5.36	0.031	1.175	49.77	9.229	0.055	0.0	9.284	0.61
TOTAL HVY TRUCK	----	8.00	0.448	0.315	----	6.77	5.133	2.196	162.22	14.664	8.793	0.489	23.945	1.56
TOT HWY GAS&DSL	----	18.77	14.163	0.548	----	15.20	146.375	4.835	1638.77	15.772	30.309	61.742	107.823	7.03
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.402	0.847	3.249	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	32.711	62.589	95.300	6.22

* 1986 *

	NEW EPA MPG	NEW ROAD MPG	NEW REGISTRATIONS (IN MILLIONS) GAS	NEW REGISTRATIONS (IN MILLIONS) DSL	FLEET EPA MPG	FLEET ROAD MPG	FLEET REGISTRATIONS (IN MILLIONS) GAS	FLEET REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) LEAD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) UNLD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) TOTAL	MMB/DAY TOTAL
PA DOM	28.00	24.03	7.731	0.070	21.49	18.26	84.807	1.207	947.24	0.534	9.971	41.362	51.866	3.38
PA IMP	33.50	28.01	2.662	0.073	29.93	24.52	23.071	0.761	283.87	0.282	2.654	8.642	11.577	0.76
TOTAL LDV	29.25	24.95	10.392	0.144	22.98	19.40	107.877	1.968	1231.11	0.815	12.625	50.003	63.444	4.14
TRUCK DOM 0-8.5	21.30	18.13	2.923	0.057	16.44	13.92	31.267	0.512	238.50	0.207	5.853	11.068	17.128	1.12
TRUCK IMP 0-8.5	27.80	23.05	0.478	0.048	25.63	21.02	4.802	0.297	42.68	0.097	0.381	1.553	2.030	0.13
TOTAL LDT	22.08	18.73	3.401	0.105	17.38	14.68	36.069	0.809	281.18	0.304	6.234	12.621	19.158	1.25
TOTAL LDV + LDT	27.54	23.46	13.793	0.249	21.68	18.31	143.946	2.777	1512.30	1.119	18.859	62.624	82.602	5.39
LT HVY TRUCKS	----	12.22	0.364	0.111	----	11.12	3.318	0.416	49.75	0.450	3.515	0.509	4.473	0.29
MED HVY TRUCKS	----	7.62	0.073	0.098	----	6.60	1.879	0.769	67.31	5.272	4.925	0.0	10.198	0.67
HVY HVY TRUCKS	----	6.29	0.0	0.124	----	5.51	0.027	1.235	51.85	9.366	0.044	0.0	9.409	0.61
TOTAL HVY TRUCK	----	8.16	0.438	0.332	----	7.01	5.223	2.420	168.91	15.088	8.484	0.509	24.081	1.57
TOT HWY GAS&DSL	----	19.67	14.231	0.581	----	15.76	149.170	5.197	1681.20	16.207	27.343	63.133	106.683	6.96
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.340	0.914	3.254	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	29.683	64.047	93.730	6.11

* 1987 *

	NEW EPA MPG	NEW ROAD MPG	NEW REGISTRATIONS (IN MILLIONS) GAS	NEW REGISTRATIONS (IN MILLIONS) DSL	FLEET EPA MPG	FLEET ROAD MPG	FLEET REGISTRATIONS (IN MILLIONS) GAS	FLEET REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) LEAD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) UNLD	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) TOTAL	MMB/DAY TOTAL
PA DOM	30.20	25.63	7.786	0.079	22.69	19.13	84.845	1.209	955.47	0.517	8.685	40.747	49.949	3.26
PA IMP	34.60	28.78	2.760	0.078	30.77	25.13	24.140	0.793	297.77	0.287	2.364	9.200	11.851	0.77
TOTAL LDV	31.25	26.40	10.546	0.157	24.20	20.28	108.985	2.001	1253.24	0.804	11.049	49.948	61.800	4.03
TRUCK DOM 0-8.5	22.20	18.81	3.042	0.062	17.19	14.56	32.705	0.562	251.90	0.216	5.223	11.861	17.299	1.13
TRUCK IMP 0-8.5	28.20	23.34	0.465	0.048	25.99	21.35	5.100	0.340	44.71	0.105	0.358	1.631	2.095	0.14
TOTAL LDT	22.89	19.35	3.507	0.110	18.11	15.29	37.805	0.902	296.61	0.321	5.581	13.492	19.394	1.27
TOTAL LDV + LDT	29.19	24.66	14.053	0.267	22.74	19.09	146.790	2.904	1549.84	1.124	16.630	63.440	81.194	5.30
LT HVY TRUCKS	----	12.45	0.364	0.121	----	11.36	3.527	0.531	54.07	0.559	3.249	0.950	4.758	0.31
MED HVY TRUCKS	----	7.81	0.078	0.108	----	6.82	1.764	0.835	68.10	5.467	4.526	0.0	9.993	0.65
HVY HVY TRUCKS	----	6.44	0.0	0.133	----	5.67	0.023	1.299	54.11	9.516	0.034	0.0	9.550	0.62
TOTAL HVY TRUCK	----	8.32	0.443	0.362	----	7.25	5.315	2.666	176.28	15.542	7.809	0.950	24.301	1.59
TOT HWY GAS&DSL	----	20.42	14.495	0.630	----	16.36	152.105	5.569	1726.12	16.667	24.439	64.390	105.496	6.88
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.279	0.984	3.263	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	26.718	65.374	92.092	6.01

* 1988 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	30.80	26.06	8.102	0.090	23.89	20.01	85.310	1.205	969.03	0.497	7.684	40.256	48.436	3.16
PA IMP	35.20	29.19	2.854	0.083	31.56	25.68	25.213	0.822	311.39	0.292	2.121	9.710	12.124	0.79
TOTAL LDV	31.85	26.82	10.955	0.174	25.39	21.14	110.523	2.027	1280.42	0.789	9.805	49.966	60.560	3.95
TRUCK DOM 0-8.5	22.60	19.11	3.193	0.069	17.93	15.19	34.219	0.617	265.71	0.226	4.669	12.604	17.498	1.14
TRUCK IMP 0-8.5	28.80	23.77	0.493	0.052	26.38	21.67	5.404	0.385	47.14	0.115	0.348	1.713	2.175	0.14
TOTAL LDT	23.32	19.67	3.686	0.121	18.84	15.90	39.623	1.002	312.86	0.340	5.017	14.316	19.673	1.28
TOTAL LDV + LDT	29.72	25.04	14.642	0.294	23.77	19.86	150.146	3.029	1593.28	1.130	14.822	64.282	80.233	5.23
LT HVY TRUCKS	----	12.26	0.383	0.134	----	11.53	3.739	0.654	58.53	0.668	2.888	1.521	5.077	0.33
MED HVY TRUCKS	----	7.60	0.080	0.116	----	6.98	1.662	0.908	69.38	5.720	4.217	0.0	9.937	0.65
HVY HVY TRUCKS	----	6.32	0.0	0.140	----	5.79	0.020	1.366	56.44	9.723	0.027	0.0	9.750	0.64
TOTAL HVY TRUCK	----	8.17	0.463	0.390	----	7.44	5.421	2.928	184.35	16.111	7.132	1.521	24.763	1.62
TOT HWY GAS&DSL	----	20.54	15.104	0.685	----	16.93	155.566	5.957	1777.63	17.241	21.953	65.802	104.997	6.85
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.244	1.032	3.276	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	24.197	66.835	91.032	5.94

* 1989 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	31.40	26.50	8.327	0.101	25.06	20.86	86.106	1.199	986.86	0.482	6.914	39.910	47.305	3.09
PA IMP	35.70	29.54	2.942	0.088	32.30	26.21	26.284	0.849	324.81	0.298	1.914	10.183	12.395	0.81
TOTAL LDV	32.44	27.24	11.268	0.190	26.53	21.97	112.390	2.049	1311.67	0.780	8.827	50.093	59.700	3.89
TRUCK DOM 0-8.5	23.20	19.56	3.309	0.074	18.62	15.76	35.763	0.675	279.86	0.237	4.268	13.249	17.754	1.16
TRUCK IMP 0-8.5	29.30	24.13	0.522	0.057	26.80	22.03	5.714	0.433	49.73	0.126	0.334	1.798	2.258	0.15
TOTAL LDT	23.93	20.12	3.831	0.131	19.52	16.47	41.477	1.108	329.60	0.363	4.602	15.047	20.012	1.31
TOTAL LDV + LDT	30.31	25.46	15.099	0.321	24.75	20.59	153.867	3.157	1641.26	1.143	13.430	65.139	79.712	5.20
LT HVY TRUCKS	----	12.70	0.398	0.147	----	11.73	3.949	0.786	63.09	0.775	2.594	2.009	5.377	0.35
MED HVY TRUCKS	----	7.77	0.081	0.123	----	7.15	1.569	0.984	71.05	5.970	3.970	0.0	9.939	0.65
HVY HVY TRUCKS	----	6.53	0.0	0.156	----	5.93	0.017	1.443	59.20	9.969	0.020	0.0	9.989	0.65
TOTAL HVY TRUCK	----	8.39	0.479	0.426	----	7.64	5.535	3.213	193.34	16.714	6.584	2.009	25.306	1.65
TOT HWY GAS&DSL	----	20.87	15.578	0.747	----	17.47	159.402	6.370	1834.60	17.856	20.014	67.148	105.018	6.85
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.210	1.083	3.292	0.21
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	22.223	68.230	90.454	5.90

* 1990 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	32.00	26.93	8.481	0.112	26.19	21.69	87.093	1.197	1007.07	0.475	6.321	39.630	46.426	3.03
PA IMP	36.30	29.95	3.015	0.093	33.01	26.71	27.340	0.877	338.32	0.303	1.749	10.613	12.665	0.83
TOTAL LDV	33.04	27.67	11.496	0.205	27.62	22.77	114.433	2.074	1345.40	0.778	8.069	50.243	59.091	3.85
TRUCK DOM 0-8.5	23.70	19.94	3.423	0.081	19.42	16.43	37.342	0.736	294.15	0.254	3.766	13.884	17.904	1.17
TRUCK IMP 0-8.5	29.80	24.48	0.545	0.061	27.27	22.41	6.026	0.484	52.67	0.138	0.319	1.893	2.350	0.15
TOTAL LDT	24.43	20.50	3.969	0.141	20.31	17.12	43.368	1.220	346.81	0.392	4.085	15.777	20.254	1.32
TOTAL LDV + LDT	30.86	25.85	15.465	0.346	25.72	21.33	157.801	3.293	1692.21	1.170	12.154	66.020	79.344	5.18
LT HVY TRUCKS	----	13.14	0.407	0.158	----	11.97	4.152	0.925	67.63	0.876	2.307	2.467	5.650	0.37
MED HVY TRUCKS	----	7.95	0.081	0.131	----	7.31	1.488	1.065	73.21	6.232	3.777	0.0	10.009	0.65
HVY HVY TRUCKS	----	6.73	0.0	0.162	----	6.07	0.014	1.521	62.01	10.200	0.015	0.0	10.215	0.67
TOTAL HVY TRUCK	----	8.65	0.488	0.451	----	7.84	5.654	3.511	202.85	17.308	6.100	2.467	25.875	1.69
TOT HWY GAS&DSL	----	21.26	15.953	0.797	----	18.01	163.455	6.804	1895.06	18.478	18.254	68.487	105.219	6.86
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.177	1.135	3.312	0.22
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	20.431	69.622	90.053	5.87

* 1991 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	32.80	27.49	8.582	0.117	27.31	22.53	88.230	1.198	1029.01	0.471	5.805	39.407	45.683	2.98
PA IMP	36.90	30.36	3.060	0.101	33.72	27.22	28.355	0.908	351.88	0.311	1.624	10.993	12.928	0.84
TOTAL LDV	33.80	28.20	11.642	0.218	28.70	23.56	116.585	2.106	1380.90	0.782	7.430	50.399	58.611	3.82
TRUCK DOM 0-8.5	24.20	20.31	3.531	0.085	20.15	17.03	38.959	0.798	309.20	0.270	3.362	14.521	18.153	1.18
TRUCK IMP 0-8.5	30.30	24.84	0.560	0.065	27.73	22.78	6.330	0.536	55.26	0.150	0.309	1.966	2.425	0.16
TOTAL LDT	24.94	20.87	4.091	0.150	21.03	17.71	45.290	1.334	364.47	0.421	3.671	16.488	20.579	1.34
TOTAL LDV + LDT	31.52	26.32	15.734	0.367	26.67	22.04	161.875	3.440	1745.36	1.202	11.100	66.887	79.190	5.17
LT HVY TRUCKS	----	13.59	0.415	0.169	----	12.24	4.347	1.068	72.15	0.978	2.016	2.900	5.895	0.38
MED HVY TRUCKS	----	8.13	0.081	0.138	----	7.48	1.417	1.149	75.83	6.508	3.630	0.0	10.137	0.66
HVY HVY TRUCKS	----	6.94	0.0	0.167	----	6.22	0.012	1.601	64.84	10.410	0.012	0.0	10.422	0.68
TOTAL HVY TRUCK	----	8.92	0.496	0.474	----	8.05	5.776	3.818	212.82	17.896	5.657	2.900	26.453	1.73
TOT HWY GAS&DSL	----	21.69	16.230	0.841	----	18.54	167.651	7.258	1958.19	19.098	16.758	69.787	105.643	6.89
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.173	1.163	3.336	0.22
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	18.931	70.950	89.881	5.86

* 1992 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	33.50	27.98	8.648	0.121	28.38	23.30	89.449	1.206	1052.19	0.465	5.314	39.388	45.167	2.95
PA IMP	37.40	30.70	3.089	0.109	34.39	27.66	29.310	0.945	365.07	0.323	1.545	11.328	13.196	0.86
TOTAL LDV	34.46	28.66	11.737	0.230	29.72	24.28	118.759	2.151	1417.26	0.788	6.859	50.716	58.363	3.81
TRUCK DOM 0-8.5	24.60	20.60	3.630	0.088	20.80	17.56	40.601	0.860	324.44	0.284	3.073	15.114	18.471	1.20
TRUCK IMP 0-8.5	30.90	25.27	0.574	0.069	28.17	23.14	6.624	0.591	57.98	0.162	0.298	2.046	2.506	0.16
TOTAL LDT	25.36	21.18	4.203	0.158	21.66	18.23	47.225	1.450	382.41	0.446	3.370	17.160	20.977	1.37
TOTAL LDV + LDT	32.08	26.71	15.940	0.388	27.54	22.68	165.985	3.601	1799.67	1.235	10.229	67.876	79.339	5.18
LT HVY TRUCKS	----	14.04	0.420	0.180	----	12.52	4.529	1.216	76.53	1.073	1.761	3.277	6.111	0.40
MED HVY TRUCKS	----	8.31	0.081	0.144	----	7.65	1.357	1.235	78.95	6.805	3.522	0.0	10.327	0.67
HVY HVY TRUCKS	----	7.15	0.0	0.171	----	6.38	0.010	1.680	67.66	10.599	0.009	0.0	10.607	0.69
TOTAL HVY TRUCK	----	9.19	0.501	0.495	----	8.25	5.895	4.131	223.15	18.476	5.292	3.277	27.045	1.76
TOT HWY GAS&DSL	----	22.07	16.441	0.883	----	19.01	171.880	7.733	2022.82	19.710	15.521	71.153	106.385	6.94
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.171	1.192	3.363	0.22
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	17.692	72.345	90.038	5.87

* 1993 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	34.29	28.53	8.686	0.125	29.39	24.02	90.614	1.222	1075.36	0.459	4.963	39.355	44.778	2.92
PA IMP	38.00	31.11	3.114	0.116	35.04	28.11	30.194	0.987	377.41	0.335	1.486	11.607	13.427	0.88
TOTAL LDV	35.21	29.18	11.800	0.241	30.68	24.96	120.808	2.208	1452.77	0.795	6.449	50.962	58.205	3.80
TRUCK DOM 0-8.5	25.10	20.99	3.682	0.130	21.49	18.13	42.222	0.959	339.80	0.315	2.913	15.516	18.744	1.22
TRUCK IMP 0-8.5	31.50	25.70	0.585	0.074	28.67	23.53	6.909	0.647	60.80	0.175	0.290	2.119	2.584	0.17
TOTAL LDT	25.87	21.57	4.267	0.204	22.34	18.78	49.131	1.606	400.60	0.490	3.203	17.635	21.328	1.39
TOTAL LDV + LDT	32.74	27.17	16.066	0.446	28.39	23.30	169.939	3.815	1853.37	1.285	9.652	68.597	79.534	5.19
LT HVY TRUCKS	----	14.26	0.430	0.184	----	12.79	4.710	1.361	80.88	1.156	1.607	3.562	6.325	0.41
MED HVY TRUCKS	----	8.52	0.081	0.150	----	7.81	1.305	1.324	82.53	7.116	3.445	0.0	10.561	0.69
HVY HVY TRUCKS	----	7.32	0.0	0.176	----	6.54	0.008	1.768	70.48	10.776	0.006	0.0	10.782	0.70
TOTAL HVY TRUCK	----	9.48	0.511	0.511	----	8.45	6.023	4.444	233.89	19.049	5.058	3.562	27.669	1.80
TOT HWY GAS&DSL	----	22.44	16.578	0.956	----	19.47	175.962	8.259	2087.26	20.333	14.710	72.159	107.203	6.99
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.172	1.222	3.394	0.22
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	16.882	73.381	90.263	5.89

* 1994 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.00	29.02	8.711	0.129	30.35	24.69	91.724	1.244	1098.14	0.459	4.737	39.278	44.474	2.90
PA IMP	38.50	31.45	3.133	0.124	35.66	28.53	31.007	1.035	389.25	0.350	1.447	11.847	13.644	0.89
TOTAL LDV	35.88	29.64	11.844	0.253	31.58	25.59	122.732	2.279	1487.39	0.809	6.184	51.125	58.117	3.79
TRUCK DOM 0-8.5	25.80	21.50	3.768	0.135	22.13	18.64	43.859	1.059	355.68	0.345	2.668	16.867	19.880	1.24
TRUCK IMP 0-8.5	31.90	25.98	0.597	0.078	29.15	23.90	7.181	0.704	63.33	0.189	0.282	2.178	2.650	0.17
TOTAL LDT	26.55	22.06	4.365	0.213	22.97	19.28	51.041	1.764	419.00	0.534	2.950	18.245	21.730	1.42
TOTAL LDV + LDT	33.38	27.62	16.209	0.466	29.18	23.88	173.772	4.043	1906.39	1.343	9.134	69.370	79.847	5.21
LT HVY TRUCKS	----	14.46	0.441	0.189	----	13.05	4.883	1.501	85.06	1.232	1.471	3.814	6.517	0.43
MED HVY TRUCKS	----	8.73	0.080	0.156	----	7.99	1.260	1.413	86.47	7.436	3.391	0.0	10.827	0.71
HVY HVY TRUCKS	----	7.50	0.0	0.180	----	6.70	0.006	1.839	73.25	10.935	0.005	0.0	10.939	0.71
TOTAL HVY TRUCK	----	9.62	0.521	0.525	----	8.65	6.149	4.753	244.78	19.603	4.867	3.814	28.284	1.84
TOT HWY GAS&DSL	----	22.81	16.730	0.991	----	19.89	179.922	8.796	2151.17	20.946	14.001	73.183	108.131	7.05
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.176	1.253	3.428	0.22
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	16.177	74.436	90.613	5.91

* 1995 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.80	29.57	8.713	0.133	31.27	25.33	92.797	1.273	1120.55	0.463	4.581	39.186	44.229	2.89
PA IMP	39.10	31.85	3.148	0.131	36.26	28.93	31.741	1.088	400.63	0.366	1.423	12.061	13.851	0.90
TOTAL LDV	36.64	30.15	11.861	0.264	32.44	26.19	124.538	2.361	1521.18	0.830	6.004	51.247	58.080	3.79
TRUCK DOM 0-8.5	26.30	21.87	3.846	0.139	22.82	19.19	45.489	1.159	371.37	0.373	2.361	16.617	19.351	1.26
TRUCK IMP 0-8.5	32.50	26.40	0.606	0.083	29.59	24.24	7.444	0.763	66.08	0.201	0.280	2.245	2.726	0.18
TOTAL LDT	27.06	22.43	4.452	0.222	23.64	19.81	52.933	1.922	437.45	0.574	2.641	18.863	22.077	1.44
TOTAL LDV + LDT	34.04	28.07	16.313	0.486	29.95	24.43	177.471	4.283	1958.63	1.404	8.645	70.109	80.157	5.23
LT HVY TRUCKS	----	14.72	0.450	0.193	----	13.32	5.051	1.637	89.10	1.302	1.333	4.056	6.690	0.44
MED HVY TRUCKS	----	8.95	0.080	0.161	----	8.16	1.223	1.503	90.87	7.775	3.357	0.0	11.133	0.73
HVY HVY TRUCKS	----	7.67	0.0	0.184	----	6.85	0.005	1.917	75.94	11.076	0.003	0.0	11.079	0.72
TOTAL HVY TRUCK	----	9.84	0.530	0.538	----	8.85	6.279	5.056	255.92	20.153	4.693	4.056	28.902	1.89
TOT HWY GAS&DSL	----	23.17	16.843	1.024	----	20.31	183.750	9.339	2214.55	21.556	13.338	74.165	109.059	7.11
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.182	1.284	3.466	0.23
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	15.520	75.449	90.969	5.93

* 1996 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.80	29.57	8.713	0.133	32.07	25.90	93.709	1.302	1141.17	0.469	4.464	39.121	44.055	2.87
PA IMP	39.10	31.85	3.148	0.131	36.77	29.26	32.380	1.139	411.12	0.383	1.404	12.265	14.052	0.92
TOTAL LDV	36.64	30.15	11.861	0.264	33.20	26.71	126.089	2.442	1552.29	0.852	5.868	51.387	58.107	3.79
TRUCK DOM 0-8.5	26.30	21.87	3.846	0.139	23.39	19.64	47.052	1.254	386.74	0.397	2.332	16.959	19.688	1.28
TRUCK IMP 0-8.5	32.50	26.40	0.606	0.083	30.04	24.59	7.684	0.818	68.55	0.213	0.276	2.299	2.788	0.18
TOTAL LDT	27.06	22.43	4.452	0.222	24.20	20.26	54.736	2.071	455.29	0.610	2.608	19.258	22.476	1.47
TOTAL LDV + LDT	34.03	28.07	16.313	0.486	30.61	24.91	180.825	4.513	2007.58	1.462	8.476	70.645	80.583	5.26
LT HVY TRUCKS	----	14.87	0.450	0.193	----	13.56	5.201	1.764	92.79	1.358	1.210	4.274	6.842	0.45
MED HVY TRUCKS	----	9.17	0.077	0.164	----	8.34	1.190	1.589	95.51	8.117	3.335	0.0	11.452	0.75
HVY HVY TRUCKS	----	7.85	0.0	0.184	----	7.01	0.004	1.989	78.42	11.179	0.002	0.0	11.182	0.73
TOTAL HVY TRUCK	----	10.05	0.527	0.541	----	9.05	6.395	5.342	266.72	20.654	4.548	4.274	29.476	1.92
TOT HWY GAS&DSL	----	23.30	16.840	1.027	----	20.66	187.220	9.855	2274.30	22.116	13.024	74.919	110.058	7.18
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.191	1.316	3.507	0.23
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	15.214	76.235	91.449	5.97

* 1997 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.80	29.57	8.713	0.133	32.78	26.41	94.491	1.332	1160.37	0.478	4.370	39.091	43.939	2.87
PA IMP	39.10	31.85	3.148	0.131	37.20	29.54	32.937	1.188	420.79	0.398	1.384	12.464	14.246	0.93
TOTAL LDV	36.64	30.15	11.861	0.264	33.85	27.18	127.428	2.519	1581.17	0.875	5.755	51.554	58.184	3.80
TRUCK DOM 0-8.5	26.30	21.87	3.846	0.139	23.83	19.99	48.542	1.342	401.57	0.416	2.295	17.379	20.090	1.31
TRUCK IMP 0-8.5	32.50	26.40	0.606	0.083	30.40	24.86	7.905	0.869	70.91	0.226	0.276	2.350	2.852	0.19
TOTAL LDT	27.06	22.43	4.452	0.222	24.63	20.60	56.447	2.212	472.48	0.642	2.570	19.729	22.941	1.50
TOTAL LDV + LDT	34.03	28.06	16.313	0.486	31.17	25.31	183.875	4.731	2053.65	1.517	8.325	71.283	81.126	5.29
LT HVY TRUCKS	----	15.08	0.450	0.193	----	13.79	5.339	1.881	96.19	1.406	1.100	4.468	6.973	0.45
MED HVY TRUCKS	----	9.38	0.075	0.166	----	8.52	1.162	1.672	100.37	8.461	3.319	0.0	11.781	0.77
HVY HVY TRUCKS	----	8.03	0.0	0.184	----	7.17	0.003	2.057	80.70	11.251	0.002	0.0	11.253	0.73
TOTAL HVY TRUCK	----	10.26	0.525	0.543	----	9.24	6.503	5.610	277.25	21.119	4.421	4.468	30.007	1.96
TOT HWY GAS&DSL	----	23.41	16.838	1.029	----	20.97	190.379	10.341	2330.90	22.636	12.745	75.751	111.133	7.25
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.202	1.349	3.551	0.23
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	14.947	77.100	92.048	6.00

* 1998 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.80	29.57	8.713	0.133	33.40	26.86	95.141	1.360	1178.22	0.487	4.235	39.150	43.872	2.86
PA IMP	39.10	31.85	3.148	0.131	37.58	29.78	33.412	1.232	429.47	0.412	1.368	12.640	14.420	0.94
TOTAL LDV	36.64	30.15	11.861	0.264	34.42	27.58	128.552	2.592	1607.70	0.898	5.603	51.790	58.291	3.80
TRUCK DOM 0-8.5	26.30	21.87	3.846	0.139	24.22	20.29	49.939	1.427	415.84	0.444	2.249	17.801	20.495	1.34
TRUCK IMP 0-8.5	32.50	26.40	0.606	0.083	30.70	25.09	8.109	0.917	73.03	0.235	0.278	2.399	2.911	0.19
TOTAL LDT	27.06	22.43	4.452	0.222	25.01	20.89	58.049	2.343	488.87	0.679	2.527	20.200	23.406	1.53
TOTAL LDV + LDT	34.03	28.06	16.313	0.486	31.64	25.66	186.601	4.935	2096.57	1.577	8.130	71.990	81.697	5.33
LT HVY TRUCKS	----	15.08	0.450	0.193	----	13.99	5.463	1.988	99.27	1.449	1.004	4.641	7.094	0.46
MED HVY TRUCKS	----	9.38	0.075	0.166	----	8.68	1.139	1.750	105.42	8.822	3.329	0.0	12.151	0.79
HVY HVY TRUCKS	----	8.03	0.0	0.184	----	7.31	0.002	2.119	82.76	11.319	0.001	0.0	11.321	0.74
TOTAL HVY TRUCK	----	10.26	0.525	0.543	----	9.40	6.604	5.857	287.45	21.591	4.334	4.641	30.566	1.99
TOT HWY GAS&DSL	----	23.40	16.838	1.029	----	21.24	193.204	10.792	2384.02	23.168	12.465	76.630	112.263	7.32
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.216	1.383	3.598	0.23
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	14.680	78.013	92.693	6.05

* 1999 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	REGISTRATIONS (IN MILLIONS) DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.80	29.57	8.713	0.133	33.89	27.20	95.787	1.386	1196.14	0.493	4.127	39.363	43.982	2.87
PA IMP	39.10	31.85	3.148	0.131	37.89	29.97	33.834	1.273	437.65	0.425	1.368	12.808	14.601	0.95
TOTAL LDV	36.64	30.15	11.861	0.264	34.88	27.89	129.621	2.659	1633.79	0.917	5.495	52.171	58.584	3.82
TRUCK DOM 0-8.5	26.30	21.87	3.846	0.139	24.56	20.56	51.251	1.506	429.27	0.462	2.179	18.240	20.881	1.36
TRUCK IMP 0-8.5	32.50	26.40	0.606	0.083	30.95	25.27	8.297	0.961	75.24	0.244	0.283	2.450	2.977	0.19
TOTAL LDT	27.06	22.43	4.452	0.222	25.34	21.15	59.548	2.467	504.51	0.706	2.462	20.690	23.858	1.56
TOTAL LDV + LDT	34.02	28.06	16.313	0.486	32.03	25.94	189.169	5.126	2138.31	1.624	7.957	72.861	82.442	5.38
LT HVY TRUCKS	----	15.08	0.450	0.193	----	14.17	5.574	2.086	102.05	1.487	0.929	4.789	7.204	0.47
MED HVY TRUCKS	----	9.38	0.075	0.166	----	8.81	1.120	1.821	110.62	9.197	3.360	0.0	12.557	0.82
HVY HVY TRUCKS	----	8.03	0.0	0.184	----	7.43	0.002	2.177	84.63	11.386	0.001	0.0	11.387	0.74
TOTAL HVY TRUCK	----	10.26	0.525	0.543	----	9.54	6.695	6.083	297.29	22.071	4.289	4.789	31.149	2.03
TOT HWY GAS&DSL	----	23.39	16.838	1.029	----	21.44	195.865	11.209	2435.60	23.695	12.246	77.650	113.590	7.41
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.232	1.417	3.649	0.24
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	14.478	79.067	93.545	6.10

* 2000 *

	NEW				FLEET									
	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	EPA MPG	ROAD MPG	REGISTRATIONS (IN MILLIONS) GAS	DSL	VMT (IN BILLIONS)	FUEL CONSUMPTION (IN BILLIONS OF GALLONS) DSL	LEAD	UNLD	TOTAL	MMB/DAY TOTAL
PA DOM	35.80	29.57	8.713	0.133	34.29	27.47	96.359	1.409	1213.25	0.497	4.130	39.533	44.160	2.88
PA IMP	39.10	31.85	3.148	0.131	38.15	30.15	34.194	1.310	445.14	0.436	1.368	12.960	14.765	0.96
TOTAL LDV	36.64	30.15	11.861	0.264	35.25	28.14	130.553	2.719	1658.39	0.933	5.498	52.493	58.925	3.84
TRUCK DOM 0-8.5	26.30	21.87	3.846	0.139	24.86	20.79	52.479	1.580	442.09	0.475	2.199	18.589	21.263	1.39
TRUCK IMP 0-8.5	32.50	26.40	0.606	0.083	31.19	25.46	8.469	1.001	77.33	0.253	0.288	2.496	3.037	0.20
TOTAL LDT	27.86	22.43	4.452	0.222	25.64	21.38	60.948	2.581	519.42	0.729	2.486	21.085	24.300	1.59
TOTAL LDV + LDT	34.02	28.06	16.313	0.486	32.36	26.17	191.501	5.300	2177.80	1.662	7.984	73.579	83.225	5.43
LT HVY TRUCKS	----	15.08	0.450	0.193	----	14.31	5.674	2.174	104.56	1.519	0.856	4.930	7.305	0.48
MED HVY TRUCKS	----	9.38	0.075	0.166	----	8.92	1.106	1.886	115.98	9.588	3.409	0.0	12.997	0.85
HVY HVY TRUCKS	----	8.03	0.0	0.184	----	7.54	0.001	2.230	86.29	11.451	0.001	0.0	11.452	0.75
TOTAL HVY TRUCK	----	10.26	0.525	0.543	----	9.66	6.781	6.290	306.83	22.558	4.265	4.930	31.753	2.07
TOT HWY GAS&DSL	----	23.37	16.838	1.029	----	21.61	198.282	11.590	2484.63	24.220	12.250	78.508	114.978	7.50
OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	2.250	1.453	3.703	0.24
HWY&OFF-HWY GAS	----	----	----	----	----	----	-----	----	-----	-----	14.500	79.961	94.461	6.16

APPENDIX C

OCTOBER 1984 OUTPUT OF THE MOTOR FUEL CONSUMPTION MODEL

FUEL USE BY VEHICLE DESIGN FUEL CATEGORY

FUEL USE BY VEHICLE DESIGN CATEGORY
IN-USE FLEET
(BILLION GALLONS)

#1982#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	19.41	3.66	0.0	23.06
UNLEAD	2.74	42.77	0.0	45.51
DIESEL	0.0	0.0	0.86	0.86
TOTAL	22.14	46.43	0.86	69.43

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
8.93	0.54	0.0	9.47
1.12	7.56	0.0	8.68
0.0	0.0	0.17	0.17
10.05	8.10	0.17	18.33

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	28.33	4.19	0.0	32.53
UNLEAD	3.86	50.34	0.0	54.20
DIESEL	0.0	0.0	1.03	1.03
TOTAL	32.19	54.53	1.03	87.76

LIGHT HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
2.82	0.0	0.0	2.82
0.39	0.0	0.0	0.39
0.0	0.0	0.07	0.07
3.21	0.0	0.07	3.28

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	31.16	4.19	0.0	35.35
UNLEAD	4.25	50.34	0.0	54.58
DIESEL	0.0	0.0	1.10	1.10
TOTAL	35.40	54.53	1.10	91.03

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
7.33	0.0	0.0	7.33
0.0	0.0	0.0	0.0
0.0	0.0	13.60	13.60
7.33	0.0	13.60	20.93

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	38.49	4.19	0.0	42.68
UNLEAD	4.25	50.34	0.0	54.58
DIESEL	0.0	0.0	14.70	14.70
TOTAL	42.74	54.53	14.70	111.97

FUEL USE BY VEHICLE DESIGN CATEGORY
NEW VEHICLES
(BILLION GALLONS)

1982

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.99	0.0	0.99
UNLEAD	0.0	5.16	0.0	5.16
DIESEL	0.0	0.0	0.20	0.20
TOTAL	0.0	6.15	0.20	6.35

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.00	0.22	0.0	0.22
UNLEAD	0.00	1.17	0.0	1.17
DIESEL	0.0	0.0	0.07	0.07
TOTAL	0.00	1.39	0.07	1.46

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.00	1.21	0.0	1.21
UNLEAD	0.00	6.33	0.0	6.33
DIESEL	0.0	0.0	0.27	0.27
TOTAL	0.00	7.54	0.27	7.81

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.33	0.0	0.0	0.33
UNLEAD	0.13	0.0	0.0	0.13
DIESEL	0.0	0.0	0.07	0.07
TOTAL	0.46	0.0	0.07	0.53

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.33	1.21	0.0	1.55
UNLEAD	0.13	6.33	0.0	6.46
DIESEL	0.0	0.0	0.34	0.34
TOTAL	0.46	7.54	0.34	8.34

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.37	0.0	0.0	0.37
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	1.27	1.27
TOTAL	0.37	0.0	1.27	1.63

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.70	1.21	0.0	1.91
UNLEAD	0.13	6.33	0.0	6.46
DIESEL	0.0	0.0	1.60	1.60
TOTAL	0.83	7.54	1.60	9.97

FUEL USE BY VEHICLE DESIGN CATEGORY
IN-USE FLEET
(BILLION GALLONS)

1985

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	8.92	4.73	0.0	14.65
UNLEAD	1.69	47.81	0.0	49.51
DIESEL	0.0	0.0	0.83	0.83
TOTAL	11.61	52.55	0.83	64.99

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
5.97	0.90	0.0	6.87
0.90	10.84	0.0	11.74
0.0	0.0	0.28	0.28
6.87	11.74	0.28	18.89

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	15.89	5.63	0.0	21.52
UNLEAD	2.60	58.66	0.0	61.25
DIESEL	0.0	0.0	1.11	1.11
TOTAL	18.48	64.29	1.11	83.88

LIGHT HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
3.33	0.0	0.0	3.33
0.49	0.0	0.0	0.49
0.0	0.0	0.35	0.35
3.82	0.0	0.35	4.17

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	19.22	5.63	0.0	24.85
UNLEAD	3.09	58.66	0.0	61.74
DIESEL	0.0	0.0	1.45	1.45
TOTAL	22.30	64.29	1.45	88.04

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
5.46	0.0	0.0	5.46
0.0	0.0	0.0	0.0
0.0	0.0	14.32	14.32
5.46	0.0	14.32	19.78

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	24.68	5.63	0.0	30.31
UNLEAD	3.09	58.66	0.0	61.74
DIESEL	0.0	0.0	15.77	15.77
TOTAL	27.77	64.29	15.77	107.82

FUEL USE BY VEHICLE DESIGN CATEGORY
NEW VEHICLES
(BILLION GALLONS)

1985

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.28	0.0	1.28
UNLEAD	0.0	6.67	0.0	6.67
DIESEL	0.0	0.0	0.07	0.07
TOTAL	0.0	7.95	0.07	8.02

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.40	0.0	0.40
UNLEAD	0.0	2.07	0.0	2.07
DIESEL	0.0	0.0	0.05	0.05
TOTAL	0.0	2.47	0.05	2.52

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.68	0.0	1.68
UNLEAD	0.0	8.74	0.0	8.74
DIESEL	0.0	0.0	0.12	0.12
TOTAL	0.0	10.42	0.12	10.54

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.46	0.0	0.0	0.46
UNLEAD	0.18	0.0	0.0	0.18
DIESEL	0.0	0.0	0.13	0.13
TOTAL	0.64	0.0	0.13	0.76

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.46	1.68	0.0	2.14
UNLEAD	0.18	8.74	0.0	8.91
DIESEL	0.0	0.0	0.25	0.25
TOTAL	0.64	10.42	0.25	11.30

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.47	0.0	0.0	0.47
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	2.09	2.09
TOTAL	0.47	0.0	2.09	2.56

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.93	1.68	0.0	2.61
UNLEAD	0.18	8.74	0.0	8.91
DIESEL	0.0	0.0	2.34	2.34
TOTAL	1.11	10.42	2.34	13.86

FUEL USE BY VEHICLE DESIGN CATEGORY
IN-USE FLEET
(BILLION GALLONS)

#1988#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	4.81	4.99	0.0	9.80
UNLEAD	0.85	49.12	0.0	49.97
DIESEL	0.0	0.0	0.79	0.79
TOTAL	5.66	54.11	0.79	60.56

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	3.77	1.24	0.0	5.02
UNLEAD	0.62	13.70	0.0	14.32
DIESEL	0.0	0.0	0.34	0.34
TOTAL	4.39	14.94	0.34	19.67

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	8.58	6.24	0.0	14.82
UNLEAD	1.47	62.81	0.0	64.28
DIESEL	0.0	0.0	1.13	1.13
TOTAL	10.05	69.05	1.13	80.23

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	2.85	0.04	0.0	2.89
UNLEAD	0.31	1.21	0.0	1.52
DIESEL	0.0	0.0	0.67	0.67
TOTAL	3.17	1.24	0.67	5.08

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	11.44	6.27	0.0	17.71
UNLEAD	1.78	64.02	0.0	65.80
DIESEL	0.0	0.0	1.80	1.80
TOTAL	13.22	70.30	1.80	85.31

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	4.24	0.0	0.0	4.24
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	15.44	15.44
TOTAL	4.24	0.0	15.44	19.69

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	15.68	6.27	0.0	21.95
UNLEAD	1.78	64.02	0.0	65.80
DIESEL	0.0	0.0	17.24	17.24
TOTAL	17.46	70.30	17.24	105.00

FUEL USE BY VEHICLE DESIGN CATEGORY
NEW VEHICLES
(BILLION GALLONS)

1988

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.21	0.0	1.21
UNLEAD	0.0	6.29	0.0	6.29
DIESEL	0.0	0.0	0.09	0.09
TOTAL	0.0	7.49	0.09	7.58

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.40	0.0	0.40
UNLEAD	0.0	2.06	0.0	2.06
DIESEL	0.0	0.0	0.05	0.05
TOTAL	0.0	2.46	0.05	2.51

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.60	0.0	1.60
UNLEAD	0.0	8.35	0.0	8.35
DIESEL	0.0	0.0	0.14	0.14
TOTAL	0.0	9.95	0.14	10.09

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.11	0.0	0.11
UNLEAD	0.0	0.56	0.0	0.56
DIESEL	0.0	0.0	0.16	0.16
TOTAL	0.0	0.66	0.16	0.83

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.71	0.0	1.71
UNLEAD	0.0	8.90	0.0	8.90
DIESEL	0.0	0.0	0.31	0.31
TOTAL	0.0	10.61	0.31	10.92

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.50	0.0	.0	0.50
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	2.35	2.35
TOTAL	0.50	0.0	2.35	2.85

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.50	1.71	0.0	2.20
UNLEAD	0.0	8.90	0.0	8.90
DIESEL	0.0	0.0	2.66	2.66
TOTAL	0.50	10.61	2.66	13.77

FUEL USE BY VEHICLE DESIGN CATEGORY
IN-USE FLEET
(BILLION GALLONS)

#1990#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	2.99	5.08	0.0	8.07
UNLEAD	0.54	49.70	0.0	50.24
DIESEL	0.0	0.0	0.78	0.78
TOTAL	3.53	54.78	0.78	59.09

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	2.61	1.47	0.0	4.09
UNLEAD	0.48	15.30	0.0	15.78
DIESEL	0.0	0.0	0.39	0.39
TOTAL	3.09	16.77	0.39	20.25

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	5.60	6.55	0.0	12.15
UNLEAD	1.02	65.00	0.0	66.02
DIESEL	0.0	0.0	1.17	1.17
TOTAL	6.62	71.55	1.17	79.34

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	2.22	0.08	0.0	2.31
UNLEAD	0.27	2.20	0.0	2.47
DIESEL	0.0	0.0	0.88	0.88
TOTAL	2.49	2.28	0.88	5.65

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	7.82	6.64	0.0	14.46
UNLEAD	1.29	67.20	0.0	68.49
DIESEL	0.0	0.0	2.05	2.05
TOTAL	9.11	73.84	2.05	85.00

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	3.79	0.0	0.0	3.79
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	16.43	16.43
TOTAL	3.79	0.0	16.43	20.22

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	11.62	6.64	0.0	18.25
UNLEAD	1.29	67.20	0.0	68.49
DIESEL	0.0	0.0	18.48	18.48
TOTAL	12.90	73.84	18.48	105.22

FUEL USE BY VEHICLE DESIGN CATEGORY
NEW VEHICLES
(BILLION GALLONS)

#1990#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.24	0.0	1.24
UNLEAD	0.0	6.44	0.0	6.44
DIESEL	0.0	0.0	0.10	0.10
TOTAL	0.0	7.68	0.10	7.78

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.41	0.0	0.41
UNLEAD	0.0	2.16	0.0	2.16
DIESEL	0.0	0.0	0.06	0.06
TOTAL	0.0	2.58	0.06	2.64

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.65	0.0	1.65
UNLEAD	0.0	8.61	0.0	8.61
DIESEL	0.0	0.0	0.17	0.17
TOTAL	0.0	10.26	0.17	10.42

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.11	0.0	0.11
UNLEAD	0.0	0.57	0.0	0.57
DIESEL	0.0	0.0	0.18	0.18
TOTAL	0.0	0.67	0.18	0.85

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.76	0.0	1.76
UNLEAD	0.0	9.17	0.0	9.17
DIESEL	0.0	0.0	0.35	0.35
TOTAL	0.0	10.93	0.35	11.28

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.47	0.0	0.0	0.47
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	2.47	2.47
TOTAL	0.47	0.0	2.47	2.95

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.47	1.76	0.0	2.23
UNLEAD	0.0	9.17	0.0	9.17
DIESEL	0.0	0.0	2.82	2.82
TOTAL	0.47	10.93	2.82	14.22

FUEL USE BY VEHICLE DESIGN CATEGORY
IN-USE FLEET
(BILLION GALLONS)

#1995#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.70	5.30	0.0	6.00
UNLEAD	0.13	51.12	0.0	51.25
DIESEL	0.0	0.0	0.83	0.83
TOTAL	0.83	56.42	0.83	58.08

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.64	2.00	0.0	2.64
UNLEAD	0.12	18.75	0.0	18.86
DIESEL	0.0	0.0	0.57	0.57
TOTAL	0.76	20.74	0.57	22.08

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	1.34	7.30	0.0	8.64
UNLEAD	0.24	69.86	0.0	70.11
DIESEL	0.0	0.0	1.40	1.40
TOTAL	1.59	77.17	1.40	80.16

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	1.01	0.32	0.0	1.33
UNLEAD	0.16	3.90	0.0	4.06
DIESEL	0.0	0.0	1.30	1.30
TOTAL	1.17	4.22	1.30	6.69

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	2.35	7.62	0.0	9.98
UNLEAD	0.40	73.76	0.0	74.17
DIESEL	0.0	0.0	2.71	2.71
TOTAL	2.75	81.39	2.71	86.85

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	3.36	0.0	0.0	3.36
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	18.85	18.85
TOTAL	3.36	0.0	18.85	22.21

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	5.71	7.62	0.0	13.34
UNLEAD	0.40	73.76	0.0	74.17
DIESEL	0.0	0.0	21.56	21.56
TOTAL	6.11	81.39	21.56	109.06

FUEL USE BY VEHICLE DESIGN CATEGORY
NEW VEHICLES
(BILLION GALLONS)

#1995#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.22	0.0	1.22
UNLEAD	0.0	6.34	0.0	6.34
DIESEL	0.0	0.0	0.13	0.13
TOTAL	0.0	7.55	0.13	7.68

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
0.0	0.44	0.0	0.44
0.0	2.31	0.0	2.31
0.0	0.0	0.10	0.10
0.0	2.75	0.10	2.85

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.66	0.0	1.66
UNLEAD	0.0	8.64	0.0	8.64
DIESEL	0.0	0.0	0.22	0.22
TOTAL	0.0	10.30	0.22	10.53

LIGHT HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
0.0	0.11	0.0	0.11
0.0	0.60	0.0	0.60
0.0	0.0	0.20	0.20
0.0	0.71	0.20	0.91

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.77	0.0	1.77
UNLEAD	0.0	9.24	0.0	9.24
DIESEL	0.0	0.0	0.42	0.42
TOTAL	0.0	11.01	0.42	11.44

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
0.43	0.0	0.0	0.43
0.0	0.0	0.0	0.0
0.0	0.0	2.53	2.53
0.43	0.0	2.53	2.96

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.43	1.77	0.0	2.20
UNLEAD	0.0	9.24	0.0	9.24
DIESEL	0.0	0.0	2.95	2.95
TOTAL	0.43	11.01	2.95	14.39

FUEL USE BY VEHICLE DESIGN CATEGORY
IN-USE FLEET
(BILLION GALLONS)

2000

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.05	5.45	0.0	5.50
UNLEAD	0.01	52.48	0.0	52.49
DIESEL	0.0	0.0	0.93	0.93
TOTAL	0.06	57.93	0.93	58.92

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
0.14	2.34	0.0	2.48
0.03	21.06	0.0	21.09
0.0	0.0	0.73	0.73
0.17	23.40	0.73	24.30

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.20	7.79	0.0	7.98
UNLEAD	0.04	73.54	0.0	73.58
DIESEL	0.0	0.0	1.66	1.66
TOTAL	0.23	81.33	1.66	83.22

LIGHT HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
0.37	0.49	0.0	0.86
0.07	4.86	0.0	4.93
0.0	0.0	1.52	1.52
0.43	5.35	1.52	7.30

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.56	8.28	0.0	8.84
UNLEAD	0.10	78.41	0.0	78.51
DIESEL	0.0	0.0	3.18	3.18
TOTAL	0.66	86.69	3.18	90.53

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

LEAD	UNLEAD	DIESEL	TOTAL
3.41	0.0	0.0	3.41
0.0	0.0	0.0	0.0
0.0	0.0	21.04	21.04
3.41	0.0	21.04	24.45

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	3.97	8.28	0.0	12.25
UNLEAD	0.10	78.41	0.0	78.51
DIESEL	0.0	0.0	24.22	24.22
TOTAL	4.07	86.69	24.22	114.98

FUEL USE BY VEHICLE DESIGN CATEGORY
NEW VEHICLES
(BILLION GALLONS)

#2000#

AUTOMOBILE DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.28	0.0	1.28
UNLEAD	0.0	6.65	0.0	6.65
DIESEL	0.0	0.0	0.14	0.14
TOTAL	0.0	7.92	0.14	8.06

LDT(0-8,500 LBS. GVW) DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.47	0.0	0.47
UNLEAD	0.0	2.44	0.0	2.44
DIESEL	0.0	0.0	0.10	0.10
TOTAL	0.0	2.91	0.10	3.01

LDV+LDT DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.74	0.0	1.74
UNLEAD	0.0	9.09	0.0	9.09
DIESEL	0.0	0.0	0.24	0.24
TOTAL	0.0	10.83	0.24	11.07

LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	0.12	0.0	0.12
UNLEAD	0.0	0.61	0.0	0.61
DIESEL	0.0	0.0	0.20	0.20
TOTAL	0.0	0.73	0.20	0.93

LDV+LDT+ LIGHT HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.0	1.86	0.0	1.86
UNLEAD	0.0	9.70	0.0	9.70
DIESEL	0.0	0.0	0.43	0.43
TOTAL	0.0	11.56	0.43	12.00

MEDIUM HEAVY + HEAVY-HEAVY TRUCK DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.43	0.0	0.0	0.43
UNLEAD	0.0	0.0	0.0	0.0
DIESEL	0.0	0.0	2.59	2.59
TOTAL	0.43	0.0	2.59	3.03

ALL HIGHWAY VEHICLES DESIGN CATEGORIES

FUEL USE	LEAD	UNLEAD	DIESEL	TOTAL
LEAD	0.43	1.86	0.0	2.30
UNLEAD	0.0	9.70	0.0	9.70
DIESEL	0.0	0.0	3.03	3.03
TOTAL	0.43	11.56	3.03	15.03

APPENDIX D

"INCIDENCE" VERSUS "VOLUME" MEASURES OF MISFUELING

The concern of two separate professional communities with the issue of fuel switching has lead to the development of two separate measures of misfueling. The first and more traditional measure is known as the "incidence" or "vehicle involvement rate." It identifies the percentage of catalyst vehicles that have used leaded gasoline at some time during the year. Due to deleterious effects of lead on catalyst and emission control system performance (and the obvious emissions implications), this measure is of intense interest to air quality modelers and EPA. The second measure ignores the number of vehicles involved and computes the leaded percentage of total gallons consumed by vehicles certified for unleaded gasoline. This measure is known as "volume rate." It is used to quantify the displacement in the distribution of leaded and unleaded gasoline that is expected from the fueling of vehicles based on their design specifications. This measure is of interest to the oil industry, DOE, and energy analysts. It is also the measure employed in the Motor Fuel Consumption Model.

Since the two measures provide information on different facets of misfueling, the same data base can provide substantially different results depending on the metric chosen. For example, the 1982 NPD data base showed that 1 year old catalyst-equipped vehicles have a 3 percent volume based misfueling rate. The corresponding measure of vehicle incidence was a 16 percent misfueling rate(40). To prevent any confusion it is important to understand the relation between these two misfueling rates.

The incidence rate shows that 16 percent of 1 year old catalyst-equipped vehicles misfueled at some point during the year. The equivalent volume rate shows that only 3 percent of the total gasoline consumed by 1 year old catalyst-equipped vehicles was leaded. The key difference between these two factors is the frequency with which vehicles misfuel. The average car makes about 50 separate fuel purchases each year. If a vehicle does misfuel the amount of leaded gasoline consumed could range from 1 gallon to over 500 gallons. The frequency with which a vehicle misfuels has no impact on the incidence rate. The fact that the vehicle has misfueled is all that is recorded in this metric. On the other hand, the frequency with which catalyst-equipped cars are filled with leaded gasoline has a significant impact on the volume rate of misfueling. The number of vehicles misfueling combined with the frequency (continuously versus occasionally) determines the volume rate.

The pattern of correct fueling and misfuelings (1 correct, 2 incorrect, 3 correct, 14 incorrect, etc.) varies considerably across any large sample of vehicles. Many measures of frequency are available to quantify this behavior. For additional information on this subject the reader is referred to Reference No. 40. The important point to be noted is that volume rates are a function of both the incidence and frequency of misfueling. Volume rates based on vehicle age have been employed in the MFC model run illustrated in this report. The actual volume rate by vehicle vintage is reported in Table 3-12 and repeated here in Table D-1.

TABLE D-1

FUEL SWITCHING RATES
BY MODEL YEAR AND VINTAGE*
(Percent)

Discretionary Switching**		Misfueling Rates**	
Model Year		Age	
1946	15.4	30	16.1
1947	15.4	29	16.1
1948	15.4	28	16.1
1949	15.4	27	16.1
1950	15.4	26	16.1
1951	15.4	25	16.1
1952	15.4	24	16.1
1953	15.4	23	16.1
1954	15.4	22	16.1
1955	15.4	21	16.1
1956	15.4	20	16.1
1957	15.4	19	16.1
1958	15.4	18	16.1
1959	15.4	17	16.1
1960	15.4	16	16.1
1961	15.4	15	16.1
1962	15.4	14	16.1
1963	15.4	13	16.1
1964	12.2	12	16.1
1965	10.3	11	16.1
1966	12.2	10	16.1
1967	9.4	9	16.1
1968	11.0	8	16.1
1969	11.0	7	13.2
1970	9.8	6	12.7
1971	6.4	5	9.2
1972	9.0	4	5.5
1973	8.7	3	4.2
1974	9.6	2	2.8
1975-2000	27.6	1	3.0

*For cars and trucks less than 14,000 lbs GVW.

**These are "volume-based" fuel switching rates.